2. ALTERNATIVES

2.1 OVERVIEW OF THE ALTERNATIVES

The U.S. Department of Energy (DOE) proposes to process certain plutonium residues and scrub alloy currently stored at the Rocky Flats Environmental Technology Site (Rocky Flats), if necessary, when those plutonium residues and scrub alloy have plutonium concentrations above safeguards termination limits (defined in box below). The Defense Nuclear Facilities Safety Board (the Board), in Recommendation 94-1 (DNFSB 1994), addressed health and safety concerns regarding various materials at Rocky Flats, including plutonium residues and scrub alloy. The Board concluded that hazards could arise from continued storage of these materials in their current form and recommended that they be stabilized. Although stabilization of the plutonium residues was addressed in the Rocky Flats Solid Residue Environmental Assessment (DOE 1996k), the processing analyzed in the Environmental Assessment would leave approximately 40 percent of the Rocky Flats plutonium residues (i.e., the plutonium residues covered by this Environmental Impact Statement [EIS]) in a form that could not be disposed of. In addition, the Environmental Assessment did not address stabilization of the scrub alloy. Since less than 10 percent of these Rocky Flats plutonium residues and none of the scrub alloy have been stabilized to date using the processes analyzed in the Rocky Flats Solid Residue Environmental Assessment, DOE considers it prudent to consider in this EIS processing alternatives that not only would stabilize the remaining plutonium residues to address the health and safety concerns raised by Board Recommendation 94-1, if necessary, but also would convert these residues into forms that would allow for their disposal or other disposition.

The plutonium residues and scrub alloy have been grouped into categories and subcategories that require similar processing technologies. Due to significant differences in the chemical and physical characteristics of the material in the various categories and in the methods required for processing them, DOE proposes to make processing or other decisions on each subcategory rather than on all of the materials in a category. The processing technologies being considered for each category are discussed in Sections 2.4.1 through 2.4.10 and in more detail in Appendix C. The environmental impacts from these alternatives are presented in Chapter 4 of this EIS.

The alternatives considered for this EIS are organized as follows:

- **Alternative 1 – No Action— Stabilize and Store—** Stabilize and repackage plutonium residues to prepare the material for interim storage as described in the *Environmental Assessment, Finding of No Significant Impact, and Response to Comments--Solid Residue Treatment, Repackaging, and Storage* (DOE 1996k) (the "Solid Residue Environmental Assessment"). Scrub alloy was not addressed in the Environmental Assessment. The No Action Alternative for scrub alloy is defined as continued storage at Rocky Flats with repackaging, as necessary. Since there is no basis for estimating how

Safeguards Termination Limits

"Safeguards" are part of the process of ensuring that unauthorized persons or organizations do not obtain materials (e.g., uranium or, for this EIS, plutonium) that could be used to manufacture nuclear weapons. Safeguards termination limits are limits on the maximum concentration of plutonium that may exist in a material without causing the material to be subject to the strict material control and accountability requirements applied under "safeguards" requirements. These concentration limits are established based on a determination of how low the plutonium concentration must be for any given material form to make the material unattractive as a source of plutonium.

long the stabilized residues and scrub alloy might have to remain in storage before a disposition mechanism would be identified, DOE analyzed in this EIS the annual impacts of such storage. The impacts of a 20-year storage period for the stabilized residues and scrub alloy are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. In addition to the storage analysis conducted in this EIS, the No Action Alternative included in the WIPP Supplemental EIS-II (DOE 1997a) presented a qualitative analysis of a much longer storage time. Under this alternative, the stabilization process would leave approximately 40 percent of the Rocky Flats plutonium residues and all of the Rocky Flats scrub alloy in a form that would not meet safeguards termination limits and, therefore, would not be eligible for disposal. Thus, while implementation of this alternative would address the most immediate health and safety concerns associated with near-term storage conditions, the indefinite storage of these materials would continue to present health and safety concerns that could only be eliminated by disposal or other disposition of the materials. All of the activities discussed under Alternative 1 would be performed at Rocky Flats.

- **Alternative 2 – Process without Plutonium Separation—**Processes that convert the material (including scrub alloy) into a form that meets safeguards termination limits for disposal at WIPP without removing plutonium from the material. All of the activities discussed under Alternative 2 would be performed at Rocky Flats.

- **Alternative 3 – Process with Plutonium Separation—**Processes that separate plutonium from the material and concentrate it so that the secondary waste meets the safeguards termination limits for disposal at WIPP while the separated and concentrated plutonium is placed in safe and secure storage pending disposition in accordance with decisions reached under the Storage and Disposition of Weapons-Usable Fissile Materials Final PEIS (DOE 1997e) and the Surplus Plutonium Disposition EIS (DOE 1998). Any plutonium separated under any alternative analyzed in this EIS would be disposed of using the immobilization process. Under this alternative, the chemical separation of plutonium from the residues and scrub alloy would be conducted in the process of accomplishing the health and safety related stabilization required to comply with Defense Nuclear Facilities Safety Board Recommendation 94-1. Processing and storage activities under Alternative 3 could be performed at Rocky Flats, the Savannah River Site, or Los Alamos National Laboratory.

- **Alternative 4 – Combination of Processing Technologies—**DOE has combined certain elements of alternatives discussed in the Draft EIS, specifically elements of Alternative 1 (No Action—Stabilize and Store) and Alternative 2 (Process without Plutonium Separation) to form Alternative 4 (Combination of Processing Technologies). Development of a separate Alternative 4 allows the Department to more clearly address management of residues that have received a variance to safeguards termination limits (see Section 1.3.1).

  The need for this alternative became apparent to DOE after consideration of the results of further characterization that was performed on the residues after the Draft EIS was issued for public review. In particular, as Rocky Flats learned more about the nature of the plutonium residues, it became apparent that much of the residue inventory would not require further stabilization prior to repackaging (the final step of each processing option analyzed under Alternatives 1 and 2) to meet the WIPP waste acceptance criteria. Even where further stabilization might be required, the stabilization could be accomplished by rather straightforward means such as calcination, neutralization and drying, or filtration and drying (as analyzed under Alternatives 1 and 2 in the Draft EIS). Thus, if a means could be found to satisfy the safeguards termination limit requirements, affected residues could be prepared for disposal in WIPP with a minimum of exposure to the public and workers, generation of less transuranic waste, lower cost, and without separation of the plutonium in those residues.

Further consideration of the mechanisms available to protect the residues prior to the time when they could be disposed of in WIPP led DOE to the conclusion that the safeguards termination requirements need not be maintained in order to ensure that the residues are sufficiently protected to meet nuclear nonproliferation concerns. Thus, a variance to the safeguards termination limits was applied for and obtained.

Alternative 4 allows analysis of alternatives for management of those categories of residues for which a variance to safeguards termination limits has been granted, as described in Section 1.3.1. Certain residues, such as plutonium fluoride residues, Ful Flo filter media residues, and the scrub alloy, are not analyzed under this alternative because they had not been identified in the Draft EIS as a material for which a variance to the safeguards termination limits had been requested, and accordingly, application of a variance was not considered for the Final EIS.

For this EIS, the "proposed action" is to process the plutonium residues and scrub alloy, if necessary, to prepare them for disposal as transuranic waste or for other disposition. The proposed action could be accomplished by either Alternatives 2, 3, or 4, or by some combination of those alternatives for different material categories or portions of one or more material categories.

DOE initially considered processing plutonium residue categories and scrub alloy at Rocky Flats, the Savannah River Site, Los Alamos National Laboratory and Lawrence Livermore National Laboratory. However, after conducting the alternative technology screening and evaluation process implemented for this EIS, DOE determined that the two national laboratories have constraints that either precluded further consideration (Lawrence Livermore National Laboratory) or limit consideration to only three processes for pyrochemical salt residues (Los Alamos National Laboratory). As a result, DOE has limited its consideration of processing sites to Rocky Flats for processes with and without plutonium separation, the Savannah River Site for two processes with plutonium separation, and Los Alamos National Laboratory for three processes with plutonium separation. The applicability of the various sites to the alternatives analyzed in this EIS is portrayed in **Figure 2–1**, and discussed further in Section 2.9.2.

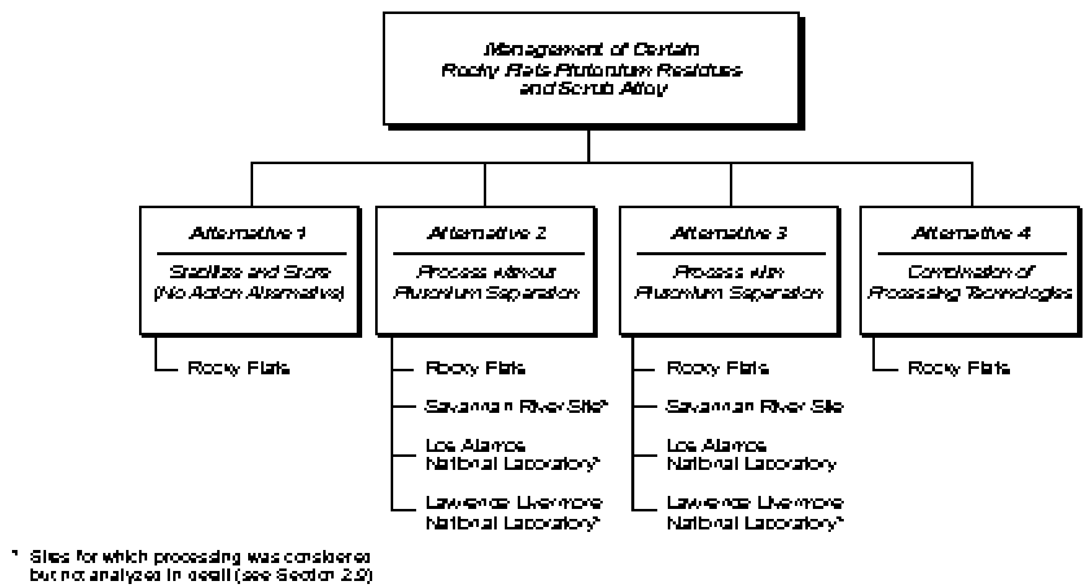

Figure 2–1 Plutonium Residue and Scrub Alloy Alternatives

Processing of the Rocky Flats plutonium residues and scrub alloy at Rocky Flats would be done primarily in two buildings at the site, Building 371 and Building 707. Building 371 would be used for processes that involve aqueous processing steps including mediated electrochemical oxidation, neutralization, sonic wash, cementation, acid dissolution, water leach, catalytic chemical oxidation, thermal desorption/steam passivation, and some blend down, cementing, and repackaging operations. Building 707 would be used for processes that are primarily thermal or physical operations including immobilization, pyro-oxidation, calcination, salt distillation, and some blend down and repackaging operations. Some processes could be done in either building. Rocky Flats would need to obtain an approved Resource Conservation and Recovery Act permit from the State of Colorado before they could process those residues with Resource Conservation and Recovery Act hazardous waste codes.

An issue has recently arisen concerning seismic events and Building 707. Analyses have determined that the return frequency for an earthquake that could cause collapse of Building 707 is 385 years. In addition, analyses have indicated that the collapse of Building 707 could collapse portions of Building 707A. The risk assessments for all processes in Buildings 707 and 707A have been revised in this Final EIS to reflect that an earthquake with a return frequency of 385 years will cause collapse of the buildings.

Several processes that involve separating plutonium (i.e., Alternative 3) are analyzed for the Savannah River Site and Los Alamos National Laboratory. These sites have unique facilities and/or processing expertise for separating plutonium from certain categories of plutonium residues and scrub alloy that are not available at Rocky Flats. It is important to be aware that some of these separation alternatives are proposed primarily due to health and safety concerns related to the increased worker radiation doses associated with the nonseparation alternatives. The Savannah River Site facilities for the separation of plutonium include the H-Canyon, HB-Line, F-Canyon, and the FB-Line. Use of these facilities, some of which are designed for remote operation, would result in lower worker radiation exposure than use of the glovebox facilities at Rocky Flats, low technical uncertainty, or low costs. For example, plutonium fluorides have the potential for an extremely high worker radiation dose due to a high neutron emission rate caused by interactions between alpha particles (generated by the radioactive decay of plutonium) and the fluorine nucleus. The plutonium separation process at the Savannah River Site (Purex) is performed in a remote-handling facility, which reduces worker dose substantially. Many of the pyrochemical salts also contain significant amounts of americium. Although the separation technologies for salts that could be processed at Los Alamos National Laboratory (salt distillation, acid dissolution/plutonium oxide recovery, and water leach) are not remote-handled, they consist of much shorter time exposures to the salts than the non-separation technology (blend-down) does, thereby reducing worker exposure substantially. Furthermore, the separation technologies would result in a smaller quantity of processed material requiring handling at the processing sites than those processes that stabilize the residues and scrub alloy through immobilization or blend down of those materials through the addition of inert or low plutonium content materials. This would further reduce worker exposure and generate less transuranic waste requiring disposal at WIPP. The reduced handling of this material at WIPP would decrease radiation exposure to the operational staff.

Los Alamos National Laboratory is considered a candidate site for three separation process technologies for materials considered in this EIS. Scientists at Los Alamos National Laboratory developed the salt distillation technology being considered for separation of plutonium oxide from certain pyrochemical salts. The site has the experience needed to apply this technology and, therefore, is included in this EIS for salt distillation. Los Alamos National Laboratory is also being considered for acid dissolution/plutonium oxide recovery and water leach of direct oxide reduction salts because of its experience with salt processing and Rocky Flats' limited capability for processing aqueous waste. Any processing activities at Los Alamos National Laboratory would be done in Building PF-4 at TA-55, the Los Alamos National Laboratory Plutonium Facility. Plutonium oxide separated from the residues would be stored at TA-55.

Many of the plutonium residues at Rocky Flats have been managed as hazardous waste under the Resource Conservation and Recovery Act, although some of this material may not fit the Resource Conservation and Recovery Act's definition of hazardous waste. Rocky Flats is in the process of further characterizing these materials to determine whether they are hazardous wastes. In addition, preprocessing at Rocky Flats would remove certain hazardous characteristics prior to shipment to another site. Hazardous wastes would not be sent to another site for processing.

In Sections 2.4 and 2.5.2, DOE has identified its preferred processing technologies for each of the Rocky Flats plutonium residue and scrub alloy material categories and subcategories. These preferences are based on a combination of factors including process technical maturity, cost, and schedule. The rationale for the preference for each material is included in the discussions about those materials in the appropriate subsections of Section 2.4.

2.2 QUANTITY AND CHARACTERISTICS OF PLUTONIUM RESIDUES AND SCRUB ALLOY AT ROCKY FLATS

Rocky Flats currently has in storage approximately 106,600 kilograms (kg) (235,000 pounds [lb]) of plutonium residues and 700 kg (1,540 lb) of scrub alloy containing approximately 3,000 kg and 200 kg (6,600 lb and 440 lb) of plutonium, respectively. DOE has determined that approximately 40 percent of the residues and 100 percent of the scrub alloy have plutonium concentrations above the safeguards termination limits.

The safeguards termination limits (see Table B–1, page B-5) specify the maximum concentrations of plutonium that may exist in plutonium-bearing materials below which the materials are not subject to the strict material control and accountability requirements applied under "safeguards" requirements. The concentration limits are determined by the difficulty in recovering plutonium from the material and are higher for plutonium embedded in solids such as glass or cement than for materials from which the plutonium is easily recoverable. The plutonium residues and scrub alloy that exceed the safeguards termination limits may require further processing beyond that described in the *Solid Residue Environmental Assessment (DOE 1996k)*, to allow for disposal or other disposition unless they have been granted a variance from safeguards termination limits. These residues and scrub alloy are the principal subject of this EIS.

The plutonium residue and scrub alloy materials subject to this EIS were described in the Notice of Intent (DOE 1996c). They have been grouped into material categories that would undergo the same set of processing technologies.

DOE recognizes that materials within these categories do not have a uniform content and that some of the processing technologies assumed for a broad material category may not be appropriate for all of the materials included in that category. DOE also recognizes that, when the storage containers are opened, the quantities and characteristics of the plutonium residues and scrub alloy may vary somewhat from those assumed in this analysis. The analyses in this EIS are based on the best knowledge of the amounts and characteristics of the plutonium residues and scrub alloy available at the time the EIS was prepared. The analysis methodologies and assumptions used in this EIS are conservative and would accommodate uncertainties in the quantities of materials to be processed. The plutonium residues and scrub alloy are briefly discussed in Chapter 1 and described in detail in Appendix B of this EIS. The five Notice of Intent categories are as follows:

- ❐ **Ash Residues—**Rocky Flats' total ash residue category consists of approximately 27,900 kg (61,500 lb) of material containing approximately 1,250 kg (2,760 lb) of plutonium in three basic groups: (1) incinerator ash, firebrick heels and fines, and soot; (2) sand, slag, and crucible; and (3) graphite fines. Approximately 72 percent of the ash residue inventory (approximately 20,060 kg or 44,200 lb) would require additional processing to meet the requirements for disposal at WIPP or other disposition alternatives.

- **Salt Residues—**Rocky Flats' total salt residue category consists of about 16,000 kg (35,300 lb) of material that contains approximately 1,000 kg (2,200 lb) of plutonium and can be subdivided into three groups: electrorefining salts, molten salt extraction salts, and direct oxide reduction salts. These salts contain sodium chloride, potassium chloride, magnesium chloride, calcium chloride, zinc chloride, and cesium chloride. Approximately 93 percent of the salt residue inventory (approximately 14,900 kg or 32,800 lb) would require additional processing to meet the requirements for disposal in WIPP or other disposition and are covered by this EIS.

- **Wet Residues—**Rocky Flats' total wet residues consist of approximately 16,500 kg (36,400 lb) of material containing approximately 340 kg (750 lb) of plutonium and are composed of a disparate assembly of materials such as wet (aqueous- and organic-contaminated) combustibles, plutonium fluorides, high-efficiency particulate air filter media, sludges, greases/oil, and Raschig (glass) rings. Approximately 26 percent of the wet residue inventory (approximately 4,300 kg or 9,500 lb) would require additional processing to meet the requirements for disposal at WIPP or other disposition alternatives.

- **Direct Repackage Residues—**Rocky Flats' direct repackage residue category consists of about 39,300 kg (86,600 lb) of material, containing about 340 kg (750 lb) of plutonium and comprises those plutonium residues that are considered to be stable and do not require processing. The residues consist of such materials as paper, rags, cloth, plastic, personal protective equipment, and gaskets. Approximately 7.8 percent of the direct repackage residue (approximately 2,900 kg or 6,400 lb) would require additional processing to meet the requirements for disposal in WIPP or other disposition and are covered by this EIS.

- **Scrub Alloy—**Scrub alloy is predominantly a magnesium/aluminum/americium/plutonium metal alloy that was created as an interim product in plutonium recovery. Scrub alloy is not considered a plutonium residue. Rocky Flats' entire scrub alloy inventory of approximately 700 kg (1,540 lb), containing approximately 200 kg (440 lb) of plutonium, will require processing to put it in a form that would meet the requirements for disposition.

For the purpose of calculating the environmental impacts, DOE has regrouped the plutonium residues and scrub alloy into new categories that require similar processing technologies. The management options for each category are described in Section 2.4. The 10 material categories used in this EIS are as follows:

1. Ash Residues
2. Pyrochemical Salt Residues
3. Combustible Residues
4. Plutonium Fluoride Residues
5. Filter Media Residues
6. Sludge Residues
7. Glass Residues
8. Graphite Residues
9. Inorganic (Metal and Others) Residues
10. Scrub Alloy

Table 2–1 shows how the 10 categories used in this EIS correspond to the 5 previously described residue and scrub alloy material categories from the Notice of Intent (DOE 1996c).

2.3 PROCESSING TECHNOLOGIES ASSESSED IN THIS EIS

The plutonium residues and scrub alloy processing technologies evaluated in this EIS were identified through a process that included review of technical reports and evaluation by technical experts from DOE Headquarters, Rocky Flats, the Savannah River Site, and Los Alamos National Laboratory. These experts also evaluated the feasibility of implementing the technologies at the DOE sites under consideration. This process is described in more detail in Section 2.9 and in Appendix C. The following documents were among those reviewed:

❒ *Environmental Assessment, Finding of No Significant Impact, and Response to Comments — Solid Residue Treatment, Repackaging, and Storage* (DOE 1996k).

❒ *Rocky Flats Environmental Technology Site: Direct Disposal Trade Study for Plutonium-Bearing Residues* (DOE 1995a).

❒ A series of trade studies on specific material categories by the DOE Nuclear Material Stabilization Task Group:

- *Plutonium Combustibles Trade Study* (DOE 1996b)
- *Plutonium Salts Trade Study* (DOE 1996n)
- *Plutonium Sand, Slag, and Crucible Trade Study* (DOE 1997f)
- *Ash Residues End-State Trade Study* (DOE 1996e)
- *Plutonium Scrub Alloy Trade Study* (DOE 1996m).

❒ *Residue Program Rebaselining: Phase I Recommendation for Rebaselining Salts, SS&C, and Graphite Fines* (Ferrera 1996) (the Rocky Flats Rebaselining Study).

❒ *Residue Program Rebaselining: Phase II Recommendation for Rebaselining Ash, Combustibles, Fluorides, Sludges, Glass, and Firebrick and Inorganics* (Gilmartin 1997).

Table 2–1 Comparison of Plutonium Residue and Scrub Alloy Material Categories

Notice of Intent Categories	*EIS Categories*
Ash Residues - Incinerator Ash, Firebrick Heels and Fines, and Soot - Sand, Slag, and Crucible - Graphite Fines	**(#1) Ash Residues (20,060 kg [44,200 lb]** containing 1,160 kg [2,560 lb] of plutonium) -Incinerator Ash and Ash Heels, and Firebrick Fines [a] -Sand, Slag, and Crucible -Graphite Fines [a] - Inorganic Ash [a]
Salt Residues - Electrorefining Salts - Molten Salt Extraction Salts - Direct Oxide Reduction Salts	**(#2) Pyrochemical Salt Residues (14,900 kg [32,800 lb]** containing 1,000 kg [2,200 lb] of plutonium) -Electrorefining Salts [a] -Molten Salt Extraction Salts [a] -Direct Oxide Reduction Salts [b]
Wet Residues - Wet Combustibles (partial)	**(#3) Combustible Residues (partial)** [a] -Aqueous/Organic-Contaminated Combustibles (685 kg [1,500 lb] containing 12 kg [26 lb] of plutonium)
- Plutonium Fluoride	**(#4) Plutonium Fluoride Residues (315 kg [690 lb]** containing 142 kg [313 lb] of plutonium)
- Wet Combustibles (partial)	**(#5) Filter Media Residues [b] (2,630 kg [5,800 lb]** containing 112 kg [250 lb] of plutonium
- Sludge - Greases/Oily Sludge	**(#6) Sludge Residues (620 kg [1,370 lb]** containing 27 kg [60 lb] of plutonium) -Sludge [a] -Greases/Oily Sludge [a]
- Raschig Rings	**(#7) Glass Residues (partial)** [a] -Raschig Rings (7.3 kg [16 lb] containing 1 kg [2.2 lb] of plutonium)
Direct Repackage Residues - Glass	**(#7) Glass Residues (partial)** [a] -Other Glass (126 kg, [280 lb] containing 4 kg [8.8 lb] of plutonium)

Notice of Intent Categories	EIS Categories
- Dry Combustibles	**(#3) Combustible Residues (partial)** [a] -Dry Combustibles (455 kg, [1,000 lb] containing 9 kg [20 lb] of plutonium)
- Graphite, Firebrick	**(#8) Graphite Residues** [a] **(1,880 kg [4,150lb]** containing 97 kg [214 lb] of plutonium) -Graphite, Firebrick
- Miscellaneous	**(#9) Inorganic Residues (Metal and Others)** [a] **(460 kg [1,000 lb]** containing 18 kg [40 lb] of plutonium) -Miscellaneous
Scrub Alloy	**(#10) Scrub Alloy (700 kg [1,540 lb]** containing 200 kg [440 lb] of plutonium)

[a] A variance to safeguards termination limits may be applied to these categories, which would allow for disposal at WIPP.
[b] A variance to safeguards termination limits may be applied to a portion of these categories, which would allow for disposal at WIPP.

Based on information in these documents, a set of potential processing technologies was identified for each material category.

With a few exceptions, each material category considered in this EIS was evaluated using the processes included in the No Action Alternative (i.e., stabilization and repackaging of residues that were considered in the Solid Residue Environmental Assessment), one or more processes that do not include separation of plutonium from the material, and one or more processes that include separation of plutonium from the material. In addition, most materials categories were also evaluated using a combination of elements from the No Action Alternative (i.e., stabilization and repackaging), processing without plutonium separation (i.e., blending to less than 10 percent plutonium), and application of a variance to the safeguards termination limits for the materials. Materials that were not evaluated for processes with plutonium separation were inorganic ash residues and sludge residues in Item Description Codes (IDCs) 089, 099, and 332. Materials that were not considered for the combination of processing technologies were plutonium fluoride residues, Ful Flo filter media residues, and scrub alloy.[1]

Because of the significant differences in the chemical and physical characteristics of the materials in various categories and in the technologies required for processing them, DOE proposes to make processing decisions on each subcategory rather than on the material categories. The technologies that apply to each of the categories are based on the best knowledge of the specifics of the processing options available at the time the EIS was prepared. These technologies are listed in **Figure 2–2** and are defined in the following sections; they are described in greater detail in Sections 2.4.1 through 2.4.10 and in Appendix C.

2.3.1 Processes Included in No Action—Stabilize and Store (Alternative 1)

The stabilization technologies analyzed for the No Action Alternative are those that were analyzed in the Solid Residue Environmental Assessment (DOE 1996k). Scrub alloy was not addressed in that Environmental Assessment. In this EIS, the No Action Alternative for scrub alloy is defined as continued storage at Rocky Flats, with repackaging as necessary. Since there is no basis for estimating how long the plutonium residues and scrub alloy might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. A material may be subjected to more than one technology conducted in series. For example,

[1]*Use of the Combination of Processing Technologies Alternative is evaluated for processing the entire inventory of direct oxide recovery salts due to uncertainties in the exact amount of material that would be processed under this alternative.*

the No Action Alternative for incinerator ash is calcination followed by cementation. Some subgroups may be subject to several different processes. All processing would take place at Rocky Flats.

2.3.2 Process without Plutonium Separation (Alternative 2)

The technologies analyzed in this EIS for processing without plutonium separation include those identified in the Plutonium Residues Trade Studies or the Rocky Flats Rebaselining Study (Ferrera 1996 and Gilmartin 1997) as mature enough for implementation by 1998-2004. A new technology, cold ceramification, has been added to the Final EIS for incinerator ash residues. Each material category in the EIS is evaluated using one or more technologies that do not involve separating plutonium from the material. All such processing would take place at Rocky Flats.

	Processing Technologies																											
	Alternative 1 NO ACTION							Alternative 2 PROCESS WITHOUT PLUTONIUM SEPARATION						Alternative 3 PROCESS WITH PLUTONIUM SEPARATION										Alternative 4 Combination of Processing Technologies				
MATERIAL CATEGORIES	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Repackaging	[illegible]
ASH RESIDUES																												
Incinerator Ash Residues	▪								▪	▪	▪					▪		▪						▪			■	
Sand, Slag, and Crucible Residues	▪								▪		▪					■								▪			▪	
Graphite Fines Residues	▪								▪		▪							▪						▪			■	
Inorganic Ash Residues	▪								▪		▪													▪			■	
PYROCHEMICAL SALT RESIDUES																												
MSE Salt Residues (IDC 409)		▪									▪								▪	▪	▪	▪					■	
MSE/ER Salt Residues (All Others)		▪									▪								▪	▪	▪	▪					■	
DOR Salt Residues (IDCs 365, 413, 417, 427)[a]		▪									▪				■						▪	▪	▪				■	
DOR Salts (All Others)		▪									▪				▪						▪	▪	▪				■	
COMBUSTIBLE RESIDUES																												
Aqueous-Contaminated			▪								▪	▪	▪				▪								■			
Organic-Contaminated				▪							▪	▪	▪				▪									■		
Dry					▪						▪	▪	▪				▪										■	
PLUTONIUM FLUORIDE RESIDUES						▪					▪			▪		■												
FILTER MEDIA RESIDUES																												
Full Flo Filters (IDC 331)			▪								■		▪				▪											
HEPA Filters (IDC 338 only)			▪						▪		▪		▪				▪								■			
HEPA Filters (All Others)			▪						▪		▪		▪				▪										■	
SLUDGE RESIDUES																												
IDCs 089, 099, and 332							▪		▪		▪																■	
All Other Sludge Residues							▪		▪		▪			▪														■
GLASS RESIDUES			▪						▪		▪		▪				▪								■			
GRAPHITE RESIDUES					▪			▪	▪		▪						▪	▪									■	
INORGANIC (Metal & Other) RESIDUES					▪				▪		▪						▪	▪									■	
SCRUB ALLOY					▪				▪							■												

■ = Preferred processing option   ▪ = Other processing options analyzed

Notes: IDC = Item Description Code; ER = Electrorefining; MSE = Molten Salt Extraction; DOR = Direct Oxide Reduction

[a] There are two preferred processing technologies for processing high plutonium concentration DOR salt residues. The rationale for having two preferred processing technologies is given in Section 2.4.3.

[b] Alternative 4 may include blending high plutonium concentration materials with similar low plutonium concentration materials or with inert materials to achieve plutonium concentrations below 10 percent.

Figure 2–2 Processing Technologies Assessed for Each Plutonium Residue and Scrub Alloy Category

2.3.3 Process with Plutonium Separation (Alternative 3)

The technologies analyzed in this EIS for processing with plutonium separation are those that were identified in the Plutonium Residues Trade Studies or the Rocky Flats Rebaselining Study (Ferrera 1996) as mature enough for implementation within the next several years. Each material category in the EIS, except for inorganic ash residues and sludge residues in IDCs 089, 099, and 332 (for which no separation technology is available), is evaluated using one or more technologies that involve separating plutonium from the material. In addition, this EIS discusses the applicability of the technologies at each of the three candidate sites—Rocky Flats, the Savannah River Site, and Los Alamos National Laboratory. A new technology, acid dissolution/plutonium oxide recovery at Los Alamos National Laboratory, has been added to the Final EIS for direct oxide reduction salt residues.

2.3.4 Combination of Processing Technologies (Alternative 4)

The stabilization, blending and repackaging technologies analyzed for Alternative 4 (Combination of Processing Technologies) are similar to technologies that were analyzed for Alternative 1 (No Action Alternative) and Alternative 2 (Processing without Plutonium Separation). Rocky Flats has determined that the high-efficiency particulate air filter media (except Item Description Code [IDC] 338) are not acid-contaminated and do not have to be neutralized and dried, and the sludge residues (with IDCs 089, 099, and 332) are not wet and do not need to be filtered and dried. These residues would be repackaged instead. Any material that is above 10 percent plutonium concentration would be blended with low plutonium concentration material from the same IDC or with inert material to reach the 10 percent limit.

During characterization of the ash and pyrochemical salt residues since the Notice of Intent to prepare this EIS, Rocky Flats determined that some of these materials do not need to be stabilized for interim storage. Material that is above 10 percent plutonium concentration would be blended with low plutonium concentration material from the same IDC or with other inert material to reach the 10 percent plutonium concentration limit. The materials would then be repacked into pipe components, which would then be placed in drums, and stored, pending shipment to WIPP for disposal as transuranic waste. All processing for Alternative 4 would take place at Rocky Flats.

2.4 MANAGEMENT ALTERNATIVES FOR EACH MATERIAL CATEGORY

The following sections cover the processing technologies and sites considered for each material category of the Rocky Flats plutonium residues and scrub alloy. Sections 2.4.1 through 2.4.10 contain brief descriptions of the material categories to be discussed, as well as descriptions of the technologies analyzed for Alternative 1 (the No Action—Stabilize and Store), Alternative 2 (Process without Plutonium Separation), Alternative 3 (Process with Plutonium Separation), and Alternative 4 (Combination of Processing Technologies). More detailed descriptions of the material categories and processing technologies may be found in Appendices B and C, respectively. The impacts are discussed in Chapter 4 and Appendix D. Figures 2–3 through 2–12 contain flow diagrams of the processing technologies for each material type. The preferred processing technologies are presented in bold.

2.4.1 Management of Ash Residues

Ash residues at Rocky Flats include materials in four subcategories: (1) incinerator ash (including ash heels and firebrick fines); (2) sand, slag, and crucible; (3) graphite fines; and (4) inorganic ash. The last category includes chloride-contaminated magnesium oxide crucible and oxide from ventilation ducts.

Some of the ash residues have been assigned hazardous waste codes under the Resource Conservation and Recovery Act. A description of hazardous waste codes is provided in Table B–4 of Appendix B. The total quantity of ash residues at Rocky Flats subject to processing is approximately 20,060 kg (44,200 lb) and includes approximately 1,160 kg (2,560 lb) of plutonium. The technology/site options analyzed for ash residues are shown in **Figure 2–3**. The impacts associated with the management of ash residues are presented in Tables 2-8 through 2-11 and in Section 4.2.

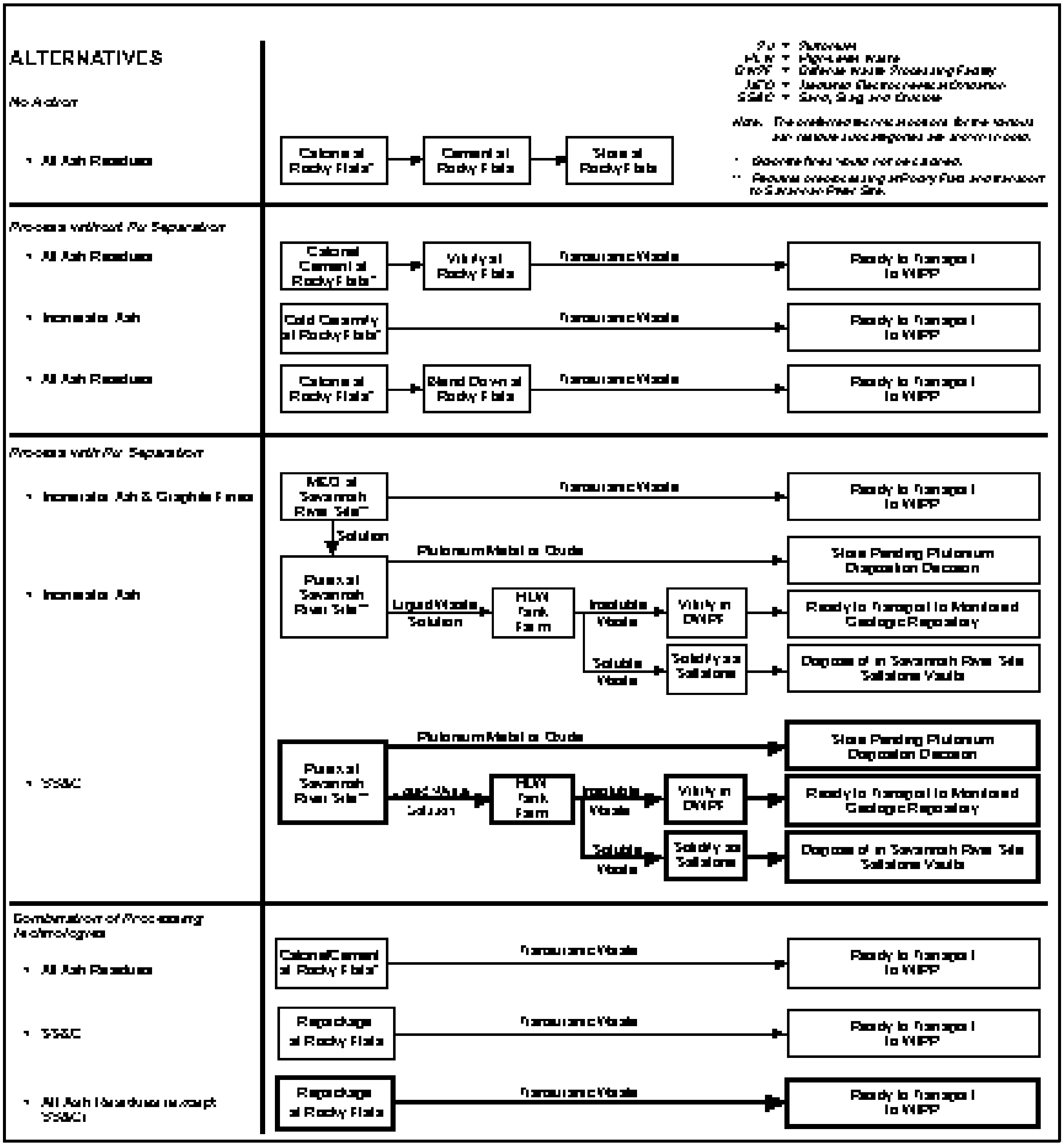

Figure 2–3 Processing Technologies for Ash Residues

DOE has identified repackage under Alternative 4 as the preferred processing technology for incinerator ash, graphite fines, and inorganic ash residues. Further characterization of these materials has shown that they do not need to be stabilized. Repackaging these materials into pipe components prior to shipment to WIPP would provide an additional measure of safety with regard to their storage, handling, transportation, and disposal.

The preferred processing technology for sand, slag, and crucible residues is preprocessing at Rocky Flats and the Purex process at the Savannah River Site (Alternative 3). This preference is based on two factors: the availability of the Savannah River Site canyons for processing the materials and possible delays in the ability to characterize this material for disposal at WIPP before the window of opportunity for processing in the canyons closes. To confirm the viability of repackaging (Alternative 4) for Rocky Flats sand, slag, and crucible, Rocky Flats would probably need to take three actions which would not be completed until at least October 1999:

- Complete additional characterization of the residue to establish a 95 percent confidence limit that no more than 5 percent could be pyrophoric.

- Obtain a modification of the WIPP TRUCON Shipping Code for sand, slag, and crucible to change the allowable passivated calcium metal content from a trace (less than 1 percent) to a minor (1-10 percent) constituent in the chemical capability code. This change could be submitted to the Nuclear Regulatory Commission in September 1998 and would require 6 to 12 months for approval.

- Obtain WIPP certification. This might require about one year.

The Savannah River Site has existing quantities of sand, slag, and crucible remaining from its own operations that will be processed in its separation canyons. The sand, slag, and crucible residues from Rocky Flats can be processed in the Savannah River Site Canyons without extending the planned operations of these facilities. The time period available for processing sand, slag, and crucible is limited and would pass prior to the earliest date that Rocky Flats could send repackaged sand, slag, and crucible to WIPP for disposal. DOE believes that it would be imprudent to forego the opportunity to process the sand, slag, and crucible at the Savannah River Site, given the uncertainties associated with repackaging and disposal at WIPP.

2.4.1.1 Alternative 1—No Action—Stabilize and Store

❒ **Calcination/Cementation—**The methodologies for stabilizing plutonium residues to meet Rocky Flats' interim safe storage criteria[2] are described in detail in the Solid Residue Environmental Assessment (DOE 1996k). The ash residues would be size-reduced by crushing and calcining and then cementing or repackaging to immobilize respirable fines. The containers of cemented and/or repackaged residues would then be placed inside 208-liter (L) (55-gal) drums in a configuration that meets the interim safe storage criteria. These drums would be stored at Rocky Flats pending final disposition. As there is no basis for estimating how long the stabilized residue might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. All stabilization activities would take place in Building 707 or Building 371. Calcination of powdered or granular materials in muffle furnaces[3] is considered to be a proven technology. Cementation of materials to immobilize fines and to form an

[2] *The interim safe storage criteria were developed in response to the Defense Nuclear Facilities Safety Board's Recommendation 94-1 (DNFSB 1994).*

[3] *Muffle furnaces are small (approximately 1 cubic foot), oven-like, electrically heated units; they are lined with refractory material, and they can be used to heat material placed onto trays inserted into the unit.*

acceptable solid is also considered to be a proven technology, although optimization studies are routinely performed to improve specific characteristics.

2.4.1.2 Alternative 2—Process without Plutonium Separation

DOE analyzed three processing technologies that do not involve plutonium separation for ash residues: vitrification, cold ceramification, and blend down with inert or low-plutonium content materials to meet the safeguards termination limits. Quantitative analyses of these technologies were conducted for processing at Rocky Flats.

- ❒ **Vitrification—**Vitrification (encapsulation in a glass matrix) was used as the technology for immobilization in conducting the impact analysis of ash residues. Vitrification (also discussed in Appendix C) is being considered at Rocky Flats for stabilization of some materials in its waste backlog and is considered to be a proven technology for most residue types to which it may be applied. A technical development program is underway for vitrification of ash residues. Vitrification is being evaluated for the plutonium residues that do not meet the safeguards termination limits in their current form. Activities are underway to optimize the process and reduce the steps necessary to achieve an acceptable waste form. In the Rocky Flats process, ash residues would be placed in Module E, Building 707. There the ash would be unpacked, sorted, size-reduced (as necessary), and measured into 8.2-L (2.2-gal) cans. The amount of ash added to the cans would be limited to 83.5 grams (g) (0.18 lb) plutonium per can. Ash residues would be calcined before being vitrified to prevent off-gases from combusting during vitrification. Glass frit would be added until the resulting material falls below the safeguards termination limits for vitrified material. The mixture would then be melted at 700 to 1,300 degrees Celsius (°C) (1,290 to 2,370 degrees Fahrenheit (°F)) to be encapsulated in glass. After cooling, the vitrified ash would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP.

- ❒ **Cold Ceramification—**Cold ceramification is a process that would stabilize residues or other materials by converting contaminated materials into chemically bonded phosphate ceramics. The residue material would be mixed with reagents such as magnesium oxide and monopotassium phosphate or phosphoric acid to produce low temperature chemical reactions that would yield a ceramic material in which the hazardous and radioactive constituents would be chemically stabilized, physically resistant, impermeable, and strong. Cold ceramification is being considered by Rocky Flats for its incinerator ash residues. Although the process is still under development, it is similar to the cementation process currently in use at Rocky Flats and uses similar equipment. In the Rocky Flats process, ash residues would be placed in a glovebox in Building 707. There the ash would be unpacked, sorted, sized-reduced (as necessary), and measured into 6-L (1.6-gal) cans. Each container would be filled to contain about 167 g (0.36 lb) of plutonium. Then magnesium oxide and monopotassium phosphate would be blended into the container with the residue. Measured quantities of water then would be blended into the containers and the material would be mixed until it thickens and appears to be homogeneous. Next, the container would be moved from the mixing station into a set of curing gloveboxes and set aside for approximately 24 hours of curing. After curing, the ceramified material would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP.

- ❒ **Blend Down—**Some material may have a plutonium concentration only slightly greater than the safeguards termination limits, or may consist of only a small quantity of material that is above the safeguards termination limits. In these circumstances, the plutonium residue may be blended down by adding material with a plutonium concentration below the safeguards termination limit so that the material may be disposed of at WIPP without further processing. The ash residue would be moved to Module B, Building 707, and bagged into the glovebox. Building 371 is under consideration as an alternative location for the blend down process. There residues would be unpacked, size-reduced as necessary, measured into batches, and calcined at 900°C (1,650°F). The calcination would oxidize any carbon or organic compounds present to carbon dioxide and would also eliminate water, or the residue could be blended with an inert material such as uranium oxide, salt, or magnesium oxide to form a mixture that meets plutonium safeguards termination limits. Calcination and blending are considered to be proven technologies.

Incinerator ash and graphite fines would be measured into batches with 83.5 g (0.18 lb) or less of plutonium, allowing for maximum packaging flexibility during the final packaging step. The sand, slag, and crucible residues and the inorganic ash residues would be measured into batches with about 18 g (0.04 lb) of plutonium because of the high ratio of dilutent to residue matrix required. After processing, the batches would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP.

2.4.1.3 Alternative 3—Process with Plutonium Separation

DOE analyzed two processes for separation of plutonium from the ash residue: the Purex process and mediated electrochemical oxidation. Quantitative analyses of these technologies were conducted for the Savannah River Site. Both of these technologies involve acid dissolution of the ash followed by conversion to plutonium metal or oxide. In the Purex process, all of the plutonium in the incinerator ash and sand, slag, and crucible residues would be converted to plutonium metal or oxide. In the mediated electrochemical oxidation process, all the ash residues (except sand, slag, and crucible; and inorganic ash) would be converted to plutonium metal or oxide. Neither the Purex nor mediated electrochemical oxidation processes can separate plutonium from the inorganic ash residues. Any plutonium separated under this alternative would be disposed of using an immobilization process.

Ash stabilization activities for incinerator ash and graphite fines would be conducted in Module E, Building 707, at Rocky Flats before shipment to the Savannah River Site. The residues requiring calcination before shipment would be unpacked in the glovebox, size-reduced as necessary, measured into batches, and calcined at 900°C (1,650°F) for two hours. The calcination would oxidize carbon and organics to carbon dioxide and would eliminate water to provide a material that would meet shipping criteria.

The existing equipment used in the Purex process at the Savannah River Site cannot process incinerator ash in its present form because the ash is not readily soluble in nitric acid. If mediated electrochemical oxidation was not used to dissolve plutonium, the incinerator ash would first be fused with an oxidant, such as sodium peroxide to convert it to a more soluble form before shipment to the Savannah River Site. The fusion process would be additional to the calcination step in the preprocessing of incinerator ash.

- **Mediated Electrochemical Oxidation at the Savannah River Site—**At the Savannah River Site, incinerator ash and graphite fines residues would be received at the Plutonium Storage Facility for interim storage. The ash residues would then be transferred to the New Special Recovery facility and dissolved using newly installed dissolvers that use the silver(II) ion to dissolve the normally intractable plutonium in the ash. These dissolvers were developed by Pacific Northwest National Laboratory, Lawrence Livermore National Laboratory, and the Savannah River Site for this purpose and are used in France to recover plutonium. The New Special Recovery facility would have to be modified for silver(II) electrochemical dissolvers. The process would also require minimal operation of the F-Canyon. An equivalent option would be to install the silver dissolver in the HB-Line and use the H-Canyon/HB-Line facilities. The mediated electrochemical oxidation process is considered to be a well demonstrated technology, although it has not yet been used in production operations in DOE facilities.

Once the plutonium was in solution, any undissolved material would be filtered out, packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP. The remaining plutonium-bearing solution would be transferred to the F-Canyon (or H-Canyon) where it would be processed through the existing Purex system to separate plutonium from waste materials in the solution. The waste fraction would be transferred to the high-level waste system, where it would be added to the materials in the high-level waste tanks. The insoluble solids would be vitrified with high-level waste in the Defense Waste Processing Facility, and the residual liquids would be solidified as saltstone. The plutonium-bearing fraction would be transferred to the FB-Line (HB-Line), where it would be precipitated as plutonium trifluoride and reduced with calcium metal to plutonium metal. [If the material is processed through the HB-Line, the final product would be plutonium oxide.] The plutonium would be thermally stabilized and packaged to meet DOE-STD-3013-96 (DOE 1996f), and placed in interim storage in the FB-Line vaults (or in the Actinide Packaging and Storage Facility, when completed), pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition Environmental Impact Statement (DOE 1997c).

- **Purex Process—**At the Savannah River Site, incinerator ash and sand, slag, and crucible residues would be received at the 235-F facility for storage. The residues would then be transferred to a Canyon facility, where they would be dissolved in nitric acid. The solution would then be separated into two fractions, a waste solution and a plutonium-bearing solution. The waste fraction would be transferred to the high-level waste system, where it would be added to the materials in the high-level waste tanks. The solids would be vitrified with high-level waste in the Defense Waste Processing Facility, and the residual liquids would be solidified as saltstone. The plutonium-bearing fraction would be transferred to a finishing line (FB/HB), where it would be precipitated and converted to a stable oxide or metal. The plutonium would be thermally stabilized, packaged to meet DOE-STD-3013-96 (DOE 1996f), and placed in interim storage in the FB-Line vaults (or in the Actinide Packaging and Storage Facility, when completed), pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition EIS (DOE 1997c). The Purex process at the Savannah River Site is considered to be a proven technology.

2.4.1.4 Alternative 4—Combination of Processing Technologies

DOE analyzed two processing technologies for ash residues under this alternative: calcination/cementation and repackaging.

- **Calcination/Cementation—**DOE would implement the same stabilization technology described under the No Action Alternative in Section 2.4.1.1, if necessary, and would apply a safeguards termination limits variance based on a maximum plutonium concentration of 10 percent plutonium. To ensure that all materials would be below the 10 percent plutonium concentration limit, high plutonium concentration material would be blended with low plutonium concentration material having the same IDC or with an inert material. After processing, the stabilized residue would be repackaged and placed in short-term storage pending disposal at WIPP as transuranic waste.

- **Repackaging—**DOE would apply a safeguards termination limit variance for materials not requiring stabilization (as determined through characterization). A variance would be based on a maximum plutonium concentration of 10 percent plutonium. To ensure that all materials would be below the 10 percent plutonium concentration limit, high plutonium concentration material would be blended with low plutonium concentration material having the same IDC or with an inert material. The materials would then be repackaged into containers and place into pipe components (see Section 2.6.1), which would then be placed into drums. The drums would be placed in short-term storage pending disposition at WIPP as transuranic waste.

2.4.2 Management of Pyrochemical Salt Residues

The primary subcategories of pyrochemical salt residues at Rocky Flats are electrorefining salt residues, molten salt extraction salt residues, and direct oxide reduction salt residues. The first two categories consist primarily of a sodium chloride/potassium chloride matrix and are contaminated with plutonium chloride, americium chloride, other metal chlorides, and significant quantities of plutonium, americium, and other metals. The direct oxide reduction salts consist primarily of a calcium chloride matrix and are contaminated with plutonium chloride, americium chloride, calcium oxide, calcium metal, plutonium oxide, plutonium fluoride, and other materials. A major difference in the possible processing of these residues is that the sodium chloride/potassium chloride matrix may be distilled from the contaminants, whereas the calcium chloride matrix is not readily distilled. The pyrochemical salt residues category also includes numerous materials that were associated with salt processing (e.g., crucibles) or that were generated during research activities. Because of technical considerations, a combination of the described processing technologies and sites may be required to process all of the pyrochemical salt residues.

The total quantity of pyrochemical salts at Rocky Flats subject to processing is approximately 14,900 kg (32,800 lb) and includes approximately 1,000 kg (2,200 lb) of plutonium. The technology/site options analyzed for processing salt residues are shown in **Figure 2–4**. The impacts associated with the management of salt residues are presented in Tables 2–12 through 2–15 and in Section 4.3.

The preferred processing technology for molten salt extraction/electrorefining salt residues and low plutonium concentration direct oxide reduction salt residues is repackaging and disposal at WIPP (Alternative 4). The plutonium concentration is low enough in these residues to be blended to 10 percent plutonium, using low plutonium concentration residues with the same characteristics or with other inert materials. This would allow the site to divert resources to other materials and to close the site at an earlier time than would be possible otherwise.

There are two preferred processing technologies for management of direct oxide reduction salt residues from Item Description Codes (IDCs) 365, 413, 417, and 427 and similar materials: (1) preprocessing at Rocky Flats followed by acid dissolution/plutonium oxide recovery at Los Alamos National Laboratory and (2) pyro-oxidation (if necessary) followed by repackaging (with blending to 10 percent plutonium, if necessary) at Rocky Flats for the remaining salt residues in these IDCs. (Although these four IDCs are sometimes called high plutonium concentration direct oxide reduction salt residues, they actually contain a mixture of high plutonium concentration and low plutonium concentration direct oxide reduction salt residues.)

DOE believes that there are only about 306 kg (675 lb) of high plutonium concentration direct oxide reduction salt residues from IDCs 365, 413, 417, and 427 that would need to be processed by the acid dissolution process at Los Alamos National Laboratory. However, a small quantity of additional material from other direct oxide reduction salt residue IDCs might be identified during physical inspection of the residues in an early part of the repackaging operation. Given this uncertainty, DOE analyzed the environmental impacts of processing up to 727 kg (1600 lb) of high plutonium concentration direct oxide reduction salt residues using the acid dissolution/plutonium oxide recovery process at Los Alamos National Laboratory. After processing, the plutonium oxide would be stored on an interim basis at Los Alamos National Laboratory in accordance with the Record of Decision issued after completion of the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1997e) until it would be disposed of in accordance with decisions to be made in the *Surplus Plutonium Disposition Environmental Impact Statement* (DOE 1997c). Plutonium contaminated magnesium oxide, a by-product of this process, would be dried and sent to WIPP for disposal as transuranic waste. The acid dissolution/plutonium oxide recovery process at Los Alamos National Laboratory would result in much shorter exposures of the workers to radiation than would be experienced with the blend down process in Alternative 2 or repackaging in Alternative 4, thus providing health and safety benefits to the workers.

The preferred processing technology for direct oxide reduction salt residues from IDCs 365, 413, 417, and 427 that would not be processed at Los Alamos National Laboratory using acid dissolution/plutonium oxide recovery would be processing at Rocky Flats using pyro-oxidation/repackaging in preparation for shipment to WIPP for disposal as transuranic waste.

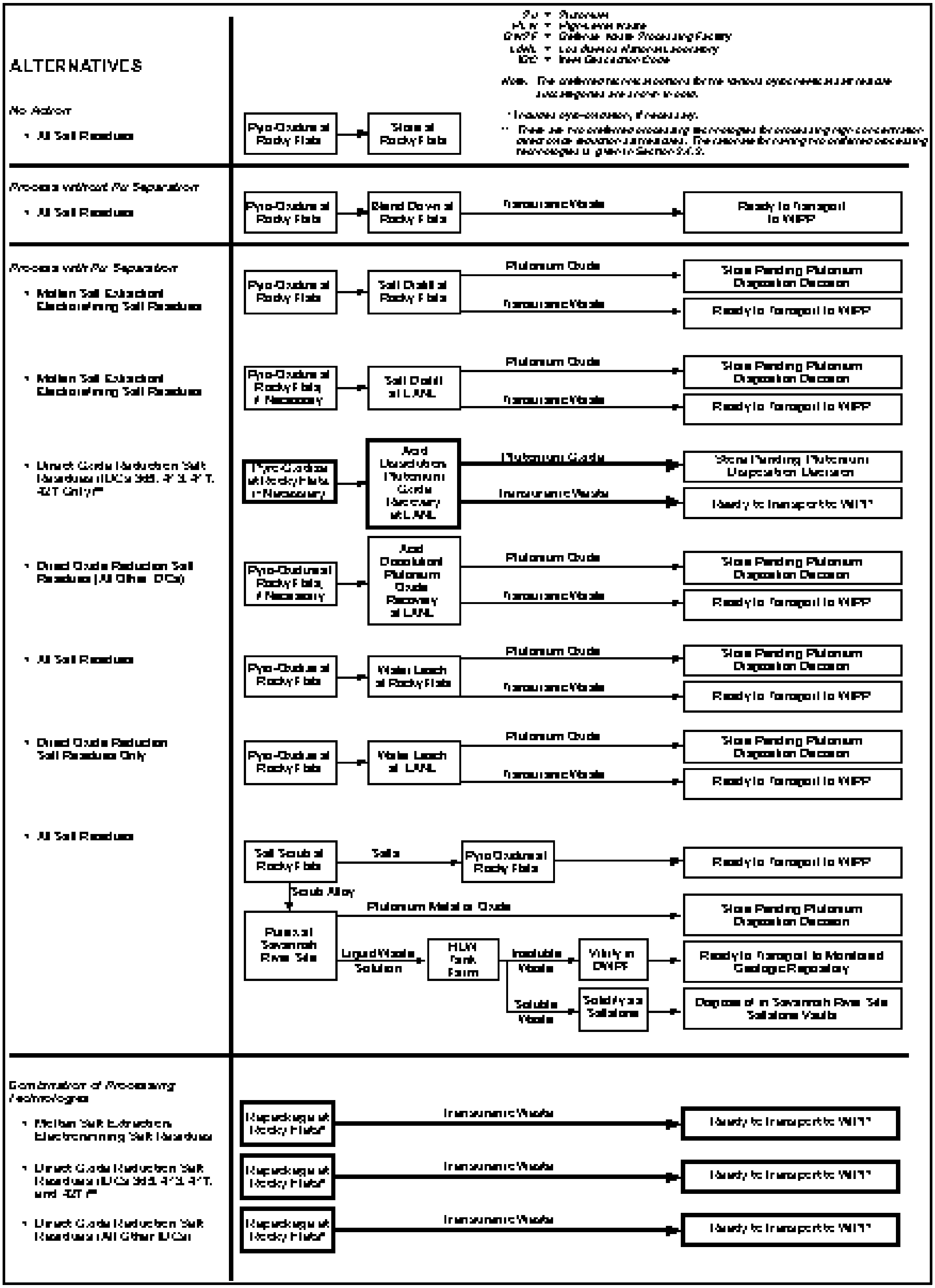

Figure 2–4 Processing Technologies for Pyrochemical Salt Residues

2.4.2.1 Alternative 1—No Action—Stabilize and Store

The methodologies for stabilizing plutonium residues to meet the Rocky Flats interim safe storage criteria are summarized below and are also analyzed in greater detail in the Solid Residue Environmental Assessment (DOE 1996k).

❒ **Pyro-Oxidation—**The salt residues under this alternative would be transferred to a glovebox in Module A of Building 707. An oxidant such as sodium carbonate would be added to the salt residue, and the mixture would be loaded into a stainless-steel can, which would be placed in a furnace, heated to about 800°C ($1,470^{\circ}$F) in an inert atmosphere, and stirred for approximately two hours. As the molten salt cools, it would solidify into a solid monolith. After cooling, the pyro-oxidized salt would be packaged, removed from the glovebox, and placed in interim storage at Rocky Flats until DOE makes a final disposition decision. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be identified, DOE has anlyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. Pyro-oxidation of salts in stationary furnaces is considered to be a proven technology.

The repackaged, stabilized salt would be assayed to determine its plutonium content, placed in secondary packaging, and transferred to the designated onsite interim storage facility until a final disposition decision is made by DOE. The purpose of this oxidation is to ensure conversion of reactive metals to nonreactive oxides.

2.4.2.2 Alternative 2—Process without Plutonium Separation

DOE analyzed pyro-oxidation followed by blending down with inert materials to the safeguards termination limit as the technology that does not involve plutonium separation. A quantitative analysis of this technology was conducted for the Rocky Flats Site.

❒ **Pyro-Oxidation/Blend Down—**The salt residues would first be pyro-oxidized, if necessary, in a metal or ceramic crucible. After cooling, the salt matrix and plutonium oxide would be removed from the crucible. The crucible would be discarded and managed as transuranic waste or sand, slag, and crucible as described in Section 2.4.1. The salt and plutonium oxide would be crushed to achieve a uniform size and then blended with an inert material (such as pure salt or uranium oxide) to form a mixture that meets the plutonium safeguards termination limits. The salt would then be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP.

2.4.2.3 Alternative 3—Process with Plutonium Separation

DOE analyzed four processing technologies for separation of plutonium from the pyrochemical salt residues: (1) salt distillation (molten salt extraction/electrorefining salt residues only), (2) acid dissolution/plutonium oxide recovery (direct oxide reduction salts only), (3) water leach, and (4) salt scrub. Quantitative analyses were conducted for: salt distillation, water leach, and salt scrub of molten salt extraction/electrorefining salt residues at Rocky Flats; salt distillation of molten salt extraction/electrorefining salt residues at Los Alamos National Laboratory; water leach of direct oxide reduction salts at Rocky Flats; and acid dissolution/plutonium oxide recovery and water leach of direct oxide reduction salt residues at Los Alamos National Laboratory. Scrub alloy produced in the salt scrub process at Rocky Flats would be transported to the Savannah River Site for separation of plutonium using the Purex process as described in Section 2.4.10. Pyro-oxidation of the salts at Rocky Flats may be required before any shipment of salt residues to Los Alamos National Laboratory. Acid dissolution/plutonium oxide recovery at Los Alamos National Laboratory was added as a process for direct oxide reduction salt residues between the Draft EIS and the Final EIS. Any plutonium separated under this alternative would be disposed of using an immobilization process.

- **Salt Distillation—**This process would separate transuranic materials from a salt matrix by distilling the salt away from any plutonium/americium oxide present in the salt. For this EIS, DOE considered salt distillation only for molten salt extraction/electrorefining salt residues. Distillation of direct oxide reduction salt residues requires further development because higher temperatures are required for calcium chloride distillation and because it does not yield a good separation of the salt from plutonium/americium oxide (these higher temperatures are beyond the capability of available equipment). The salt would be pyro-oxidized, if necessary, and then loaded into the salt distillation furnace and heated under vacuum to approximately 950°C (1,740°F) for approximately six hours. Under these conditions, the salts would distill away from the plutonium/americium oxides in the mixture. No hazardous chemicals would be released during this process. After the separation, the furnace would be cooled and opened. The separated salts and plutonium/americium oxide/residual salts would then be assayed, packaged, and handled by two separate paths. The separated salts would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP. The plutonium/americium oxides would be packaged according to DOE-STD-3013-96 (DOE 1996f) and placed in safe interim storage pending disposition in accordance with decisions reached under the Storage and Disposition of Weapons-Usable Fissile Materials Final PEIS (DOE 1997e) and the Surplus Plutonium Disposition EIS (DOE 1997c).

  Pyro-oxidation of salts is considered to be a proven technology, although specific process variables are being evaluated in an attempt to make the pyro-oxidation process more compatible with a pyro-distillation follow-on processing step. Salt distillation of the sodium chloride/potassium chloride matrix from molten salt extraction/electrorefining salts has been well demonstrated on a pilot scale with actual residue materials, although optimization studies are ongoing and final designs of the production equipment will be required. An additional uncertainty involved in the salt distillation process is the disposition of the transuranic oxide materials resulting from distillation of salts from molten salt extraction salts. These materials contain elevated concentrations of americium compared to other plutonium oxide materials, resulting in elevated gamma radiation levels that may require extra shielding and special handling procedures.

- **Acid Dissolution/Plutonium Oxide Recovery at Los Alamos National Laboratory—**Recovery of plutonium from direct oxide reduction salt residues by acid dissolution at the Los Alamos National Laboratory would be conducted inside gloveboxes located in the Los Alamos Plutonium Facility (TA-55). The process would consist of dissolving the material in hydrochloric acid, followed by precipitation of the plutonium with oxalic acid, and then calcination to plutonium oxide.

  Acid dissolution would consist of first preparing a mixture containing equal amounts of salt residue and water and then adding concentrated hydrochloric acid to the mixture. Sodium chlorite next would be added to convert plutonium to the four valence state. This plutonium-bearing solution would be mixed with an organic solution consisting of tributylphosphate in dodecane. In the resulting solvent extraction process, plutonium would move into the organic phase while americium and calcium chloride salt, the matrix in direct oxide reduction salt residues, would remain in the aqueous phase. After the acid and organic solutions separate from one another, the aqueous phase would be sent to the raffinate tank for further processing. The organic phase would be stripped of plutonium using dilute hydrochloric acid and recycled. Hydroxylamine hydrochloride would then be added to the dilute acid solution containing plutonium to reduce plutonium to the three valence state.

Addition of oxalic acid to the plutonium-bearing solution would cause plutonium to precipitate as plutonium oxalate. The slurry would be filtered through a stainless steel filter and washed with dilute oxalic acid. Magnesium hydroxide would be added to the filtrate from oxalate precipitation and the raffinate from solvent extraction to precipitate any remaining plutonium and americium in those solutions. The magnesium hydroxide would then be filtered, calcined at 450°C (840°F), packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP. The filtrate from the magnesium hydroxide precipitation process would be sent to TA-50, the Liquid Waste Treatment Facility. The plutonium oxalate filter cake on the stainless steel filter boat would be placed in a calcining furnace and heated to 400°C (750°F) for one hour to decompose the plutonium oxalate to plutonium oxide and carbon dioxide and evaporate any entrained water. After cooling, the plutonium oxide would be removed from the filter boat, sampled, weighed, and packaged for temporary storage. The plutonium oxide would then be thermally stabilized at 1,000°C (1,830°F) for four hours, packaged according to DOE-STD-3013-96 (DOE 1996f), and placed in interim storage pending disposition in accordance with decisions reached under the Storage and Disposition of Weapons-Usable Fissile Materials Final PEIS (DOE 1997e) and the Surplus Plutonium Disposition EIS (DOE 1997c). This process is a proven technology.

- **Water Leach—**The dissolution process being considered for recovery of plutonium/americium oxides from pyrochemical salts is water leach of the salt. In this process, the salt would first be pyro-oxidized, if necessary, as previously described in Section 2.4.2.1. The salt would then be placed in the leaching vessel and water would be added. Because the pyro-oxidation process produces an excess of sodium oxide, hydrochloric acid must be added to prevent the resulting solution from becoming excessively alkaline. After approximately one hour, the slurry would be vacuum filtered. The solid filter cake would consist primarily of damp plutonium/americium oxide, which would be placed in a furnace and dried at 400°C (750°F) for four hours. After drying, the plutonium/americium oxide would be calcined at 1,000°C (1,830°C) for four hours. No hazardous chemicals would be released during this process. The plutonium/americium oxide would be packaged according to DOE-STD-3013-96 (DOE 1996f) and placed in interim storage pending disposition in accordance with decisions reached under the Storage and Disposition of Weapons-Usable Fissile Materials Final PEIS (DOE 1997e) and the Surplus Plutonium Disposition EIS (DOE 1997c). The filtrate would be evaporated, leaving a lean salt that would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposition at WIPP.

  The water leach process is considered to be a proven technology. However, if it is used to process molten salt extraction salts, an uncertainty exists involving the disposal of the transuranic oxide materials remaining from the water leach of molten salt extraction salts. This is the same problem discussed above for salt distillation of these salts. The residual materials contain elevated concentrations of americium compared to other plutonium oxide materials, resulting in elevated gamma radiation levels that must be addressed in handling. Estimates of radiation levels from these oxides indicate that the materials require special handling procedures or shielding to be received at the new vault being constructed at the Savannah River Site.

- **Salt Scrub—**Salt scrub is the technology historically used to recover plutonium from molten salt extraction/electrorefining salt residues. This technology can also be used for direct oxide reduction salt residues. The salt residue would be placed in a crucible with a mixture of aluminum and magnesium (or, in newer processes, gallium and calcium) and heated in a glovebox furnace to approximately 800°C (1,470°F) for approximately two hours. Any plutonium and americium chlorides present in the residue would be reduced by magnesium (or calcium) to plutonium and americium metals, which would then be extracted by the aluminum (or gallium). The alloy would then separate from the salts and form a metallic button (called scrub alloy) at the bottom of the crucible.

After cooling, the salts and scrub alloy button would be removed from the crucible and separated from one another. The residual salts would be analyzed to determine if they meet safeguards termination limits for disposal at WIPP. Salts that meet the limits would be pyro-oxidized (as described previously in Section 2.4.2.1) to oxidize any reactive metals, packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP. Salts that do not meet the safeguards termination limits would be scrubbed again. The scrub alloy would be sent to the Savannah River Site to be processed in the Canyons using the Purex process (Section 2.4.10).

The salt scrub process is considered to be a proven process for clean, recently packaged salt residues. However, technical uncertainties exist for this process as applied to less pure salts and/or salts that have absorbed moisture during storage. Development work would be required prior to or in parallel with the operations to address these uncertainties, with the result possibly being a population of salts not amenable to this technique. Since the scrub alloy process could be performed in the stationary furnaces that have been installed at Rocky Flats as part of the No Action Alternative, a currently installed capability exists to support this process. The salts scrubbed by this process, however, may not meet the safeguards termination limits for disposal at WIPP and may need some subsequent processing prior to disposition.

2.4.2.4 Alternative 4—Combination of Processing Technologies

DOE analyzed repackaging at Rocky Flats as the only processing technology for pyrochemical salt residues under this alternative.

❒ **Repackaging—**DOE would apply a variance to the safeguards termination limits (or otherwise administratively terminate safeguards) for materials not requiring stabilization, although small quantities may be pyro-oxidized, if necessary. A variance would be based on a maximum plutonium concentration of 10 percent plutonium. To ensure that all materials would be below the 10 percent plutonium concentration limit, high plutonium concentration material would be blended with low plutonium concentration material having the same IDC. The materials would then be repackaged into containers and placed into pipe components, which would then be placed into drums. The drums would be placed in short-term storage pending disposition at WIPP as transuranic waste.

2.4.3 Management of Combustible Residues

The combustible plutonium residues are divided into three subcategories: aqueous-contaminated combustibles, organic-contaminated combustibles, and dry combustibles. These residues are solid materials contaminated with plutonium; they include gloves, clothes, and other combustible materials. Some of the combustible residues have been assigned hazardous waste codes under the Resource Conservation and Recovery Act. A description of the hazardous waste codes is provided in Table B–4 of Appendix B. After stabilization, these materials would no longer be ignitable, corrosive, or reactive. Such materials could be managed under Alternatives 1 or 4. Materials with the other hazardous waste codes meet the WIPP waste acceptance criteria (DOE 1996j). The total quantity of Rocky Flats combustible residues subject to processing is approximately 1,140 kg (2,510 lb) and includes approximately 21 kg (46 lb) of plutonium. The technology/site options analyzed for processing these residues are shown in **Figure 2–5**. The impacts of processing combustible residues are presented in Table 2–16 and Section 4.4.

DOE's preferred processing technology for all combustible residues is to stabilize and repackage the residues as described in Alternative 4 and send the residues to WIPP for disposal. Implementation of a variance to the safeguards termination limits for those residues would allow Rocky Flats to process the residues more rapidly and to close the site. The stabilization processes would be the same as those described for Alternative 1 (No

Action Alternative). For aqueous-contaminated combustible residues, the stabilization process would be neutralization followed by drying, with any fines stabilized by cementation or repackaging; for organic-contaminated combustible residues, it would be a combination of washing, low-temperature thermal desorption to remove volatile organic materials, stabilization of plutonium fines, mixing with an absorbent material, and cementation; and for dry combustible residues, it would be just to repackage the materials for disposal because they are already in a chemical or physical form that does not require stabilization. These are the technologies that are described in the Rocky Flats Solid Residue Environmental Assessment (DOE 1996k).

2.4.3.1 Alternative 1—No Action—Stabilize and Store

All processing activities for combustibles under the No Action Alternative would be conducted in existing glovebox lines in Building 371 at Rocky Flats. Specific stabilization methods for the aqueous-contaminated and organic-contaminated combustibles, as well as for dry combustibles, are described in the following paragraphs.

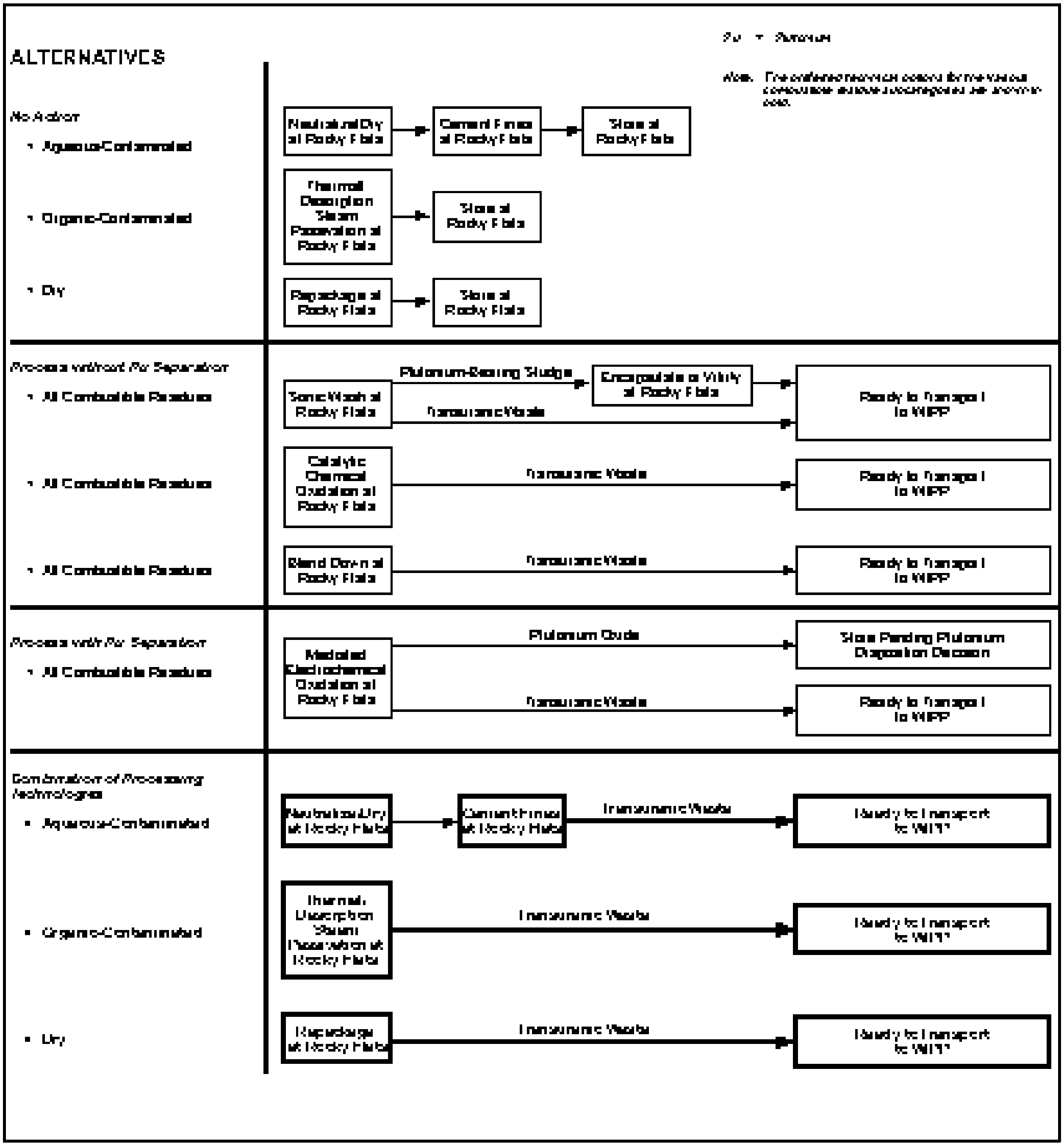

Figure 2–5 Processing Technologies for Combustible Residues

❒ **Neutralize/Dry—**Aqueous-contaminated combustibles are combustible materials that contain or have been exposed to discernible quantities of water-based solutions (typically acids or bases). Larger items would be size-reduced to facilitate washing. The materials would be washed with a neutralizing solution, excess liquid would be removed by filtration, and the remaining residues would be dried either by mixing with an absorbent material or by drying at low temperatures. Any fines resulting from this process would be immobilized by cementation or packaging. The remaining residue would be repackaged for interim storage until final disposition. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. The washing solution would be periodically withdrawn, assayed for plutonium content, and sent to the liquid waste treatment facility. This process is currently in use at Rocky Flats.

- ❒ **Thermal Desorption/Steam Passivation—**The organic-contaminated combustibles would be stabilized by washing, low-temperature (approximately 80°C [176°F]) thermal desorption to remove volatile organic materials, stabilization of plutonium fines, mixing with an absorbent material, and cementation. Steam would be added to the low-temperature thermal desorption to stabilize plutonium fines. The stabilized residue would be repackaged for interim storage until final disposition. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. This process is considered to be a proven technology; however, final process parameters are currently under investigation (for more details see Appendix C).

- ❒ **Repackage—**Dry combustible residues are in a chemical or physical form that does not require stabilization to meet interim safe storage criteria. The present packaging configuration, however, does not meet those criteria. Accordingly, these residues would be directly repackaged, without stabilization, into metal containers meeting interim safe storage criteria. After repackaging, the residue containers would be sent to an appropriate storage area until final disposition. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. Repackaging is considered to be an acceptable alternative.

2.4.3.2 Alternative 2—Process without Plutonium Separation

DOE analyzed three technologies that do not involve plutonium separation for processing combustible residues: sonic wash, catalytic chemical oxidation, and blend down with inert materials to the safeguards termination limits. Quantitative analyses of these technologies were conducted for processing at Rocky Flats.

- ❒ **Sonic Wash—**The sonic wash technology is applicable to all three subcategories of combustible residues. In this process, plutonium is physically removed from solid hydrogenous and other insoluble matrices by washing in a weak caustic solution with agitation induced by sound waves in the sonic range. The process mechanically improves contact of the neutralizing solution with the irregular matrix surfaces and improves the removal of solid transuranic oxides from the surface of the feed matrices. The feed material would be shredded, placed in a basket, and lowered into a sonic wash unit that contained a weak caustic solution. The charge would be agitated by sonic waves and a portion of the oxides, along with other higher density materials, would wash off the matrix and settle to the bottom. The matrix material would be rinsed, dried, and repackaged for shipment to WIPP for disposal. The settled heavy materials or sludges containing the higher fraction of transuranic oxides would be filtered from the wash solution, dried, and stored until a batch large enough to vitrify is gathered. The material first would be blended with a low-melting temperature glass, then heated to 700 to 1,300°C (1,290 to 2,370°F) to melt the glass and encapsulate or vitrify the waste. The stabilized material would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP. The effluent streams from the filtration and rinsing steps would be evaporated and recycled back to the sonic wash unit.

The sonic wash technology has been demonstrated with residue-type materials on a bench scale. Because of the significant effort required to demonstrate a consistent process and develop the procedures and analysis necessary for routine operation, DOE estimates that this process would be available two years after the issuance of the Records of Decision for this EIS.

- **Catalytic Chemical Oxidation (Digestion)—**The process used to represent digestion of organic materials in combustible residues is the catalytic chemical oxidation process. This process uses catalysts dissolved in acid to oxidize organic materials and to dissolve metals associated with the residues at elevated temperatures and pressures. Any metals present, including plutonium, would be converted to metal oxides by boiling down the solution. The residual metal oxides would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP.

  Catalytic chemical destruction of combustibles at elevated temperatures and pressures has been demonstrated in a commercial environment, but is unproven as a production process in the size and service required and for residue material applications. Because of the significant effort required to demonstrate a consistent process and to develop the procedures and analysis necessary for routine operations, the estimated time to deploy this technology would be four years after the issuance of the Records of Decision for this EIS.

- **Blend Down—**Some materials that have plutonium concentrations only slightly above the safeguards termination limits may be shredded for efficient packing and blended with low-plutonium concentration materials (e.g., residues containing plutonium below the safeguards termination limits) or other appropriate materials. These materials would be introduced into a glovebox, shredded, diluted with other materials as required, and repackaged. The new packages would then be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP.

2.4.3.3 Alternative 3—Process with Plutonium Separation

DOE analyzed mediated electrochemical oxidation for all three kinds of combustible residues. A quantitative analysis of this technology was conducted for processing at Rocky Flats. Any plutonium separated under this alternative would be disposed of using an immobilization process.

- **Mediated Electrochemical Oxidation—**This process uses silver ions generated in an electrochemical cell to catalyze the dissolution of unreactive plutonium materials from residues and, depending on the substrate material, to convert some "combustible" materials into carbon dioxide and water. To ensure that a large surface area was exposed to the solution, the material would be shredded. Then the materials would be placed in a corrosion-resistant wire basket to allow solid-solution contact while maintaining the ability to remove the undissolved solids easily.

  In the mediated electrochemical oxidation dissolution process, a solution of silver nitrate in nitric acid would be pumped into an electrochemical cell, where the silver(I) ion would be oxidized to the silver(II) ion. The solution would be pumped immediately into the reaction tank, where it would dissolve plutonium oxide contained in the matrix, most organic and carbonaceous materials, and many other contaminants. Any solid material remaining after the reaction would be filtered, washed, dried, packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP.

  Plutonium dissolved in the process would be mixed with a solution of oxalic acid, causing the plutonium to precipitate as plutonium oxalate. The slurry would be filtered through a stainless steel filter boat and washed with dilute nitric acid. The filtrate would be evaporated to recycle much of the water and acid, and the evaporator bottoms would be neutralized, cemented, and packaged for shipment to WIPP for disposal. The plutonium oxalate filter cake on the stainless steel filter boat would be placed in a calcining furnace and heated to 400°C (750°F) for four hours to decompose the oxalate and entrained water into the glovebox atmosphere, leaving a dry plutonium oxide cake. After cooling, the plutonium oxide would be removed from the filter boat, sampled, weighed, and packaged for temporary storage. Later, the plutonium oxide would be thermally stabilized, packaged according to DOE-STD-3013-96 (DOE 1996f), and placed in interim storage pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition EIS (DOE 1997c). The remediated electrochemical oxidation process is considered to be a well demonstrated technology, although it has not yet been used in production operations in DOE facilities.

2.4.3.4 Alternative 4—Combination of Processing Technologies

DOE analyzed three processing technologies for combustible residues under Alternative 4. The analyses were based on application of a safeguards termination limit variance for a maximum 10 percent plutonium concentration to the stabilized residues. To ensure that all materials would be below the 10 percent plutonium concentration limit, high plutonium concentration material would be blended with low plutonium concentration material having the same IDC or with an inert material.

- **Neutralize/Dry—**This is the same stabilization technology described under the No Action Alternative in Section 2.4.3.1. DOE would apply a safeguards termination limit variance to these materials. After neutralization and drying, the stabilized residue would be repackaged and placed in short-term storage pending disposal at WIPP as transuranic waste.

- **Thermal Desorption/Steam Passivation—**This is the same stabilization technology described under the No Action Alternative in Section 2.4.3.1. DOE would apply a safeguards termination limit variance for these materials. After thermal desorption and steam passivation, the stabilized residue would be repackaged and placed in short-term storage pending disposal at WIPP as transuranic waste.

- **Repackage—**This is the same repackaging technology described under the No Action Alternative in Section 2.4.3.1. DOE would apply a safeguards termination limit variance to these materials. After repackaging, the stabilized residue would be placed in short-term storage pending disposal at WIPP as transuranic waste.

2.4.4 Management of Plutonium Fluoride Residues

The plutonium fluoride residues at Rocky Flats, which were generated in the hydrofluorination and reduction operations, are solid materials that have a high plutonium content. The alpha-neutron reaction, which occurs between alpha particles emitted from plutonium and fluorine, results in a high neutron emission rate from these residues and may cause a high neutron exposure to workers. The total quantity of Rocky Flats plutonium fluorides needing processing is approximately 315 kg (690 lb) and includes approximately 140 kg (310 lb) of plutonium. The technology/site options analyzed for plutonium fluoride residues are shown in **Figure 2–6**. The impacts associated with the management of plutonium fluorides are presented in Table 2–17 and Section 4.5.

DOE has identified the Purex process at the Savannah River Site (Alternative 3) as the preferred processing technology for processing plutonium fluoride residues because the Savannah River Site has existing operations (i.e., the F- and H-Canyons) that can process the material remotely, thus exposing the workers to less radiation

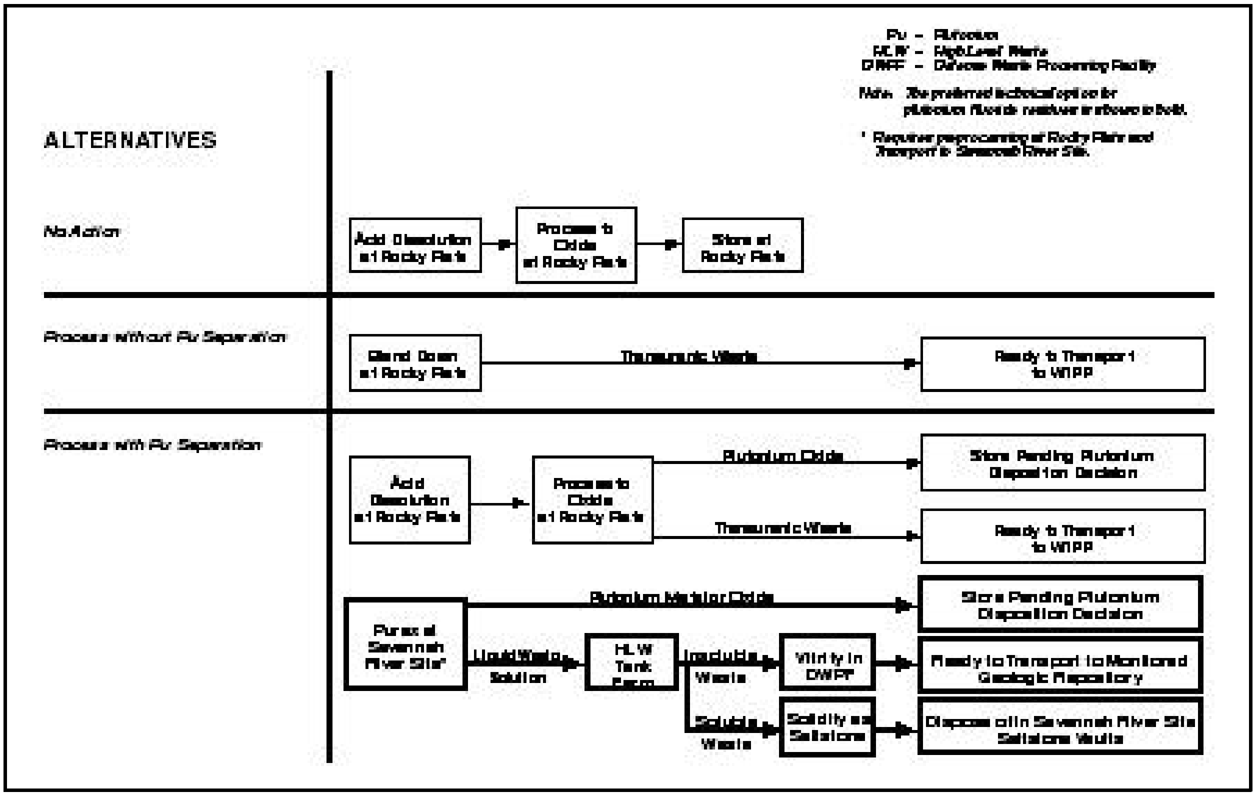

Figure 2–6 Processing Technologies for Plutonium Fluoride Residues

from alpha-n reactions than glovebox operations at Rocky Flats. Accordingly, significant health and safety benefits would accrue to workers by using the Purex process at the Savannah River Site.

2.4.4.1 Alternative 1—No Action—Stabilize and Store

❒ **Acid Dissolution/Plutonium Oxide Recovery—**Plutonium would be recovered from plutonium fluoride by dissolving the material in nitric acid. The resulting solution would be mixed with a solution of oxalic acid, causing the plutonium to precipitate as plutonium oxalate. The slurry would be filtered through a stainless steel filter boat and washed with dilute nitric acid. Magnesium hydroxide would be added to the precipitation filtrate to precipitate any remaining plutonium. This material would be filtered, calcined at 450°C (840°F), and repackaged for interim storage until final disposition. The plutonium oxalate filter cake on the stainless steel filter boat would be placed in a calcining furnace and heated to 450°C (840°F) for four hours, decomposing the oxalate and evaporating entrained water into the glovebox atmosphere and leaving a dry plutonium oxide cake. After cooling, the plutonium oxide would be removed from the filter boat, sampled, weighed, and packaged for temporary storage. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. The plutonium oxide would then be thermally stabilized, packaged according to DOE-STD-3013-96 (DOE 1996f), and placed in interim storage. This process is considered to be a proven technology.

2.4.4.2 Alternative 2—Process without Plutonium Separation

DOE analyzed blending the fluoride with inert materials to the safeguards termination limits as the processing technology without plutonium separation. A quantitative analysis of this technology was conducted for processing at Rocky Flats.

- ❒ **Blend Down—**The only technology applicable for this residue category is to blend the plutonium fluoride with an inert material such as uranium oxide, magnesium oxide, or salt. Although this material has a large concentration of plutonium (approaching 50 percent plutonium, by weight), the small quantity of this residue may make blending down reasonable. The processed material would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP.

2.4.4.3 Alternative 3—Process with Plutonium Separation

DOE analyzed two technologies for separation of plutonium from plutonium fluoride residues: acid dissolution followed by plutonium oxide recovery and the Purex process. Quantitative analyses of these technologies were conducted for the acid dissolution process at Rocky Flats and for the Purex process at the Savannah River Site. Note that the No Action Alternative (Alternative 1) would also separate plutonium from plutonium fluoride; however, under the No Action Alternative the plutonium would remain in storage at Rocky Flats. Any plutonium separated under this alternative would be disposed of using an immobilization process.

- ❒ **Acid Dissolution/Plutonium Oxide Recovery—**This is the same technology that would be used in the No Action Alternative. The plutonium oxide recovered would be packaged according to DOE-STD-3013-96 (DOE 1996f) and stored pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition EIS (DOE 1997c).

- ❒ **Purex Process—**This is the same technology previously described (in Section 2.4.1.3) for ash residues. The plutonium fluoride residues would be packaged for shipment to the Savannah River Site. At the Savannah River Site, the material would be dissolved in nitric acid in a Canyon facility and then recovered as metal or oxide in the Canyon finishing line.

2.4.4.4 Alternative 4—Combination of Processing Technologies

DOE is not evaluating the use of any technology option for the plutonium fluoride residue category under this alternative.

2.4.5 Management of Filter Media Residues

Two types of solid filter media residues exist at Rocky Flats—high-efficiency particulate air filters and Ful Flo filters. The high-efficiency particulate air filters are made of fiberglass and may be treated like other glasses; the Ful Flo filters are made from organic polymers. Some filter media residues at Rocky Flats have the Resource Conservation and Recovery Act hazardous waste designation for corrosivity. Upon treatment under the No Action Alternative (Alternative 1), the filters would be neutralized and would no longer be corrosive. Accordingly, the resultant transuranic wastes could be sent to WIPP for disposal. All other processes for filter media residues, except the blend down process, would also remove the corrosivity characteristic. The resulting transuranic wastes are acceptable for disposal at WIPP. [See Table 3.4.2.3-2 of the WIPP Waste Acceptance Criteria, Revision 5 (DOE 1996j).]

The total quantity of filter media needing processing is approximately 2,630 kg (5,800 lb) and includes approximately 110 kg (240 lb) of plutonium. The processing technology/site options analyzed for filter media residues are shown in **Figure 2–7**. The impacts associated with the management of filter media residues are presented in Tables 2–18 through 2–20 and in Section 4.6.

DOE has identified blend down (Alternative 2) as the preferred alternative for Ful Flo filter media (IDC 331). This material was not identified in the Draft EIS as a material for which a variance to the safeguards termination limit had been requested, and accordingly, application of a variance was not considered for the Final EIS. The other viable processes for this residue are aqueous processes for which Rocky Flats has limited capacity. Neutralize/dry (Alternative 4) is the preferred processing technology for high-efficiency particulate air filter media (IDC 338). This material is contaminated with nitric acid and must be neutralized and dried prior to shipment to WIPP. DOE has determined that the remaining high-efficiency particulate air filter media residues are not wet and, therefore, do not need to be neutralized and dried. Accordingly, they would be repackaged under Alternative 4 and sent to WIPP for disposal. The average concentration of plutonium in the high-efficiency particulate air filter media residues is less than 10 percent, allowing them to be sent to WIPP for disposal with little processing. This would allow the site to reduce radiation risk to the public and workers, divert resources to processing other materials, and close the site at an earlier time than would be possible otherwise.

2.4.5.1 Alternative 1—No Action—Stabilize and Store

- ❒ **Neutralize/Dry—**These filter media would be neutralized and dried as described in Section 2.4.3.1. The product would be placed in interim storage until final disposition. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period.

2.4.5.2 Alternative 2—Process without Plutonium Separation

DOE analyzed three processing technologies for filter media residues that do not involve plutonium separation: vitrification (high-efficiency particulate air filter media only), blend down with inert materials to the safeguards termination limits, and sonic wash. Quantitative analyses of these technologies were conducted for processing at Rocky Flats.

- ❒ **Vitrification (High-Efficiency Particulate Air Filter Media Only)—**High-efficiency particulate air filter media are composed of fiberglass material; thus, they can be stabilized by mixing with glass frit and then heating until a vitrified melt is formed. The technology analyzed for high-efficiency particulate air filter media is the same as described in Section 2.4.1.2 for ash residues.

- ❒ **Blend Down—**Filter media may be shredded and blended with inert materials to meet the safeguards termination limits. Rocky Flats would use the same methodology previously described for combustible materials in Section 2.4.3.2.

- ❒ **Sonic Wash—**The sonic wash process uses sound waves to dislodge particles of plutonium oxide and other contaminants from the filter media. Then the media would be disposed of as transuranic waste, and the residual plutonium-bearing sludge would be stabilized by vitrification and also disposed of as transuranic waste. Rocky Flats would use the same process previously described for combustible materials in Section 2.4.3.2.

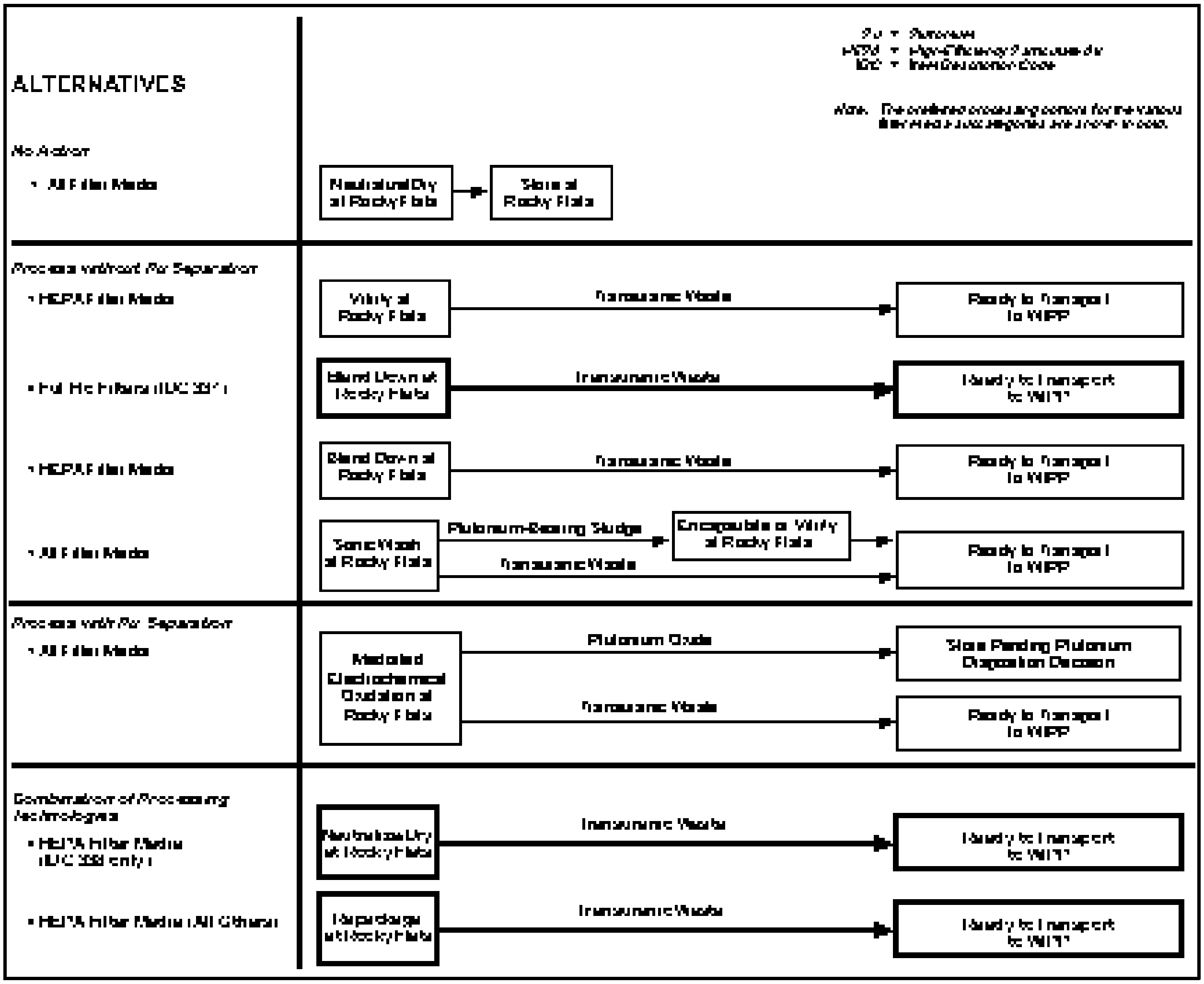

Figure 2–7 Processing Technologies for Filter Media Residues

2.4.5.3 Alternative 3—Process with Plutonium Separation

DOE analyzed mediated electrochemical oxidation for processing of filter media residues with plutonium separation. A quantitative analysis of the impacts of implementing this technology at Rocky Flats was conducted. Any plutonium separated under this alternative would be disposed of using an immobilization process.

❒ **Mediated Electrochemical Oxidation—**This technology was described previously in Section 2.4.3.3. Plutonium dissolved in the process would be precipitated as an oxalate and then calcined to plutonium oxide. The oxide would then be thermally stabilized, packaged according to DOE-STD-3013-96 (DOE 1996f), and placed in interim storage pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition EIS (DOE 1997c). Other solid material would be dried, stabilized, packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP.

2.4.5.4 Alternative 4—Combination of Processing Technologies

DOE analyzed two processing technologies, neutralize/dry at Rocky Flats for high-efficiency particulate air filter media residues (IDC 338) and repackage for all other high-efficiency particulate air filter media residues. A description of these materials may be found in Section B.3.6 of Appendix B. In the No Action Alternative, all filter media were analyzed together and were assumed to be wet with nitric acid; however, DOE has determined that only materials in IDCs 331 and 338 contain nitric acid and require neutralization and drying for stabilization. The analyses were based on application of a variance to the safeguards termination limit for a maximum 10 percent plutonium concentration. To ensure that all materials would be below the 10 percent plutonium concentration limit, high plutonium concentration material would be blended with low plutonium concentration material having the same IDC, or with an inert material. Processing under this alternative was not considered for Ful Flo filter media (IDC 331).

- ❒ **Neutralize/Dry—**This is the same technology described under the No Action Alternative in Section 2.4.5.1. DOE would apply a variance to the safeguards termination limit for the high-efficiency particulate air filter media residues with IDC 338. After neutralization and drying, the stabilized residue would be placed in short-term storage pending disposal at WIPP as transuranic waste.

- ❒ **Repackaging—**This technology would apply to all high-efficiency particulate air filter media residues except for those with IDC 338. The material would be repackaged to meet the WIPP waste acceptance criteria and the 10 percent plutonium variance to the safeguards termination limit; then it would be placed in short-term storage pending disposal at WIPP as transuranic waste.

2.4.6 Management of Sludge Residues

Sludges were generated by a variety of processes at Rocky Flats. Some of the sludge residues at Rocky Flats have Resource Conservation and Recovery Act hazardous waste designations. (See Table 3.4.2.3-2 of the WIPP Waste Acceptance Criteria, Revision 5 (DOE 1996j).) Sludges with corrosivity hazardous waste designations would be neutralized prior to shipment to WIPP to remove the corrosivity characteristic. The total quantity of sludges needing processing is approximately 620 kg (1,370 lb), including approximately 27 kg (60 lb) of plutonium. The technology/site options analyzed for sludge residues are shown in **Figure 2–8**. The impacts associated with the management of sludge residues are presented in Tables 2–21 and 2–22 and Section 4.7.

DOE has identified the repackage process (Alternative 4) as the preferred processing technology for the sludge residues with IDCs 089, 099, and 332, because these greases and oily sludges are not easily processed by other means and because of the small quantity (7.0 kg [15.4 lb] bulk, 0.95 plutonium) that would be repackaged. (A description of the materials in each item description code is presented in Appendix B.) The preferred alternative for all other sludge residues is filtration followed by drying (Alternative 4) because implementation of the variance would allow Rocky Flats to process the material most expeditiously and close the site.

2.4.6.1 Alternative 1—No Action—Stabilize and Store

- ❒ **Filter/Dry—**The stabilization process assumed in the No Action Alternative is to process miscellaneous sludges by filtering off any excess liquid and drying the remaining material by mixing with an absorbent. The resulting dried material would be tested to determine if respirable fines are present. Any fines present would be immobilized using a process such as cementation. The final step would be to repackage the residue for interim storage until final disposition. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be

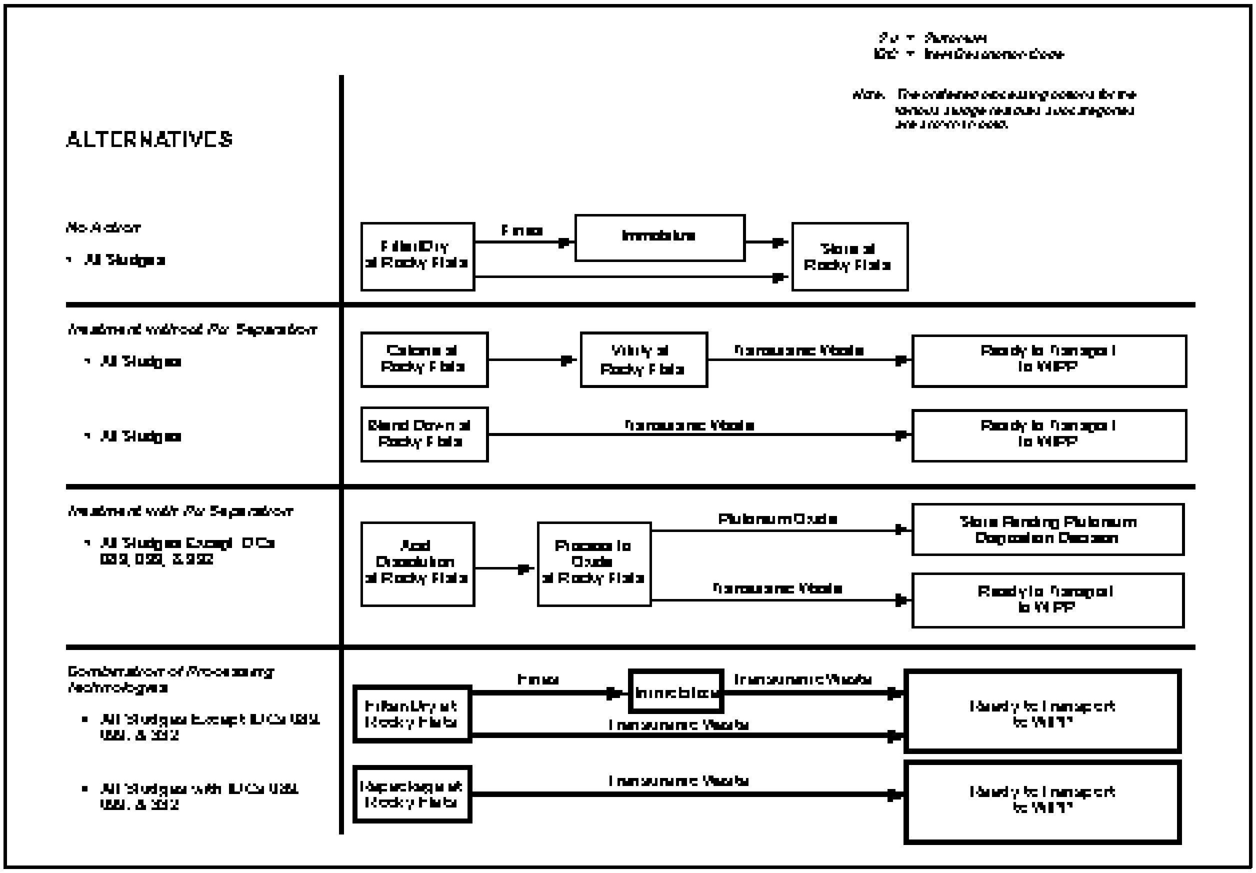

Figure 2–8 Processing Technologies for Sludge Residues

identified, DOE has analyzed the annual impacts of such storage in this EIS. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with the perspective on the effects of a prolonged storage period. The small quantity of liquid would be sent to the Rocky Flats liquid waste treatment facility. This process is considered to be a proven technology.

2.4.6.2 Alternative 2—Process without Plutonium Separation

DOE analyzed two technologies for processing sludge residues, including greases and oily sludge residues, that do not involve plutonium separation: vitrification and blend down with inert materials to the safeguards termination limits. Quantitative analyses of these technologies were conducted for processing at Rocky Flats.

❒ **Vitrification—**Vitrification of sludges at Rocky Flats would be done in a furnace placed inside a glovebox. The procedure used would be the same as the procedure for ash residues described in Section 2.4.1.2.

❒ **Blend Down—**Sludge residues would be blended with an inert material, such as uranium oxide or magnesium oxide, to form a mixture that meets plutonium safeguards termination limits. The residues would be analyzed for plutonium content; moved to Module B, Building 707; and bagged into the glovebox. The residues would then be unpacked, size-reduced as necessary, diluted by mixing with an inert material (including an absorbent to dry any free liquids), packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP.

2.4.6.3 Alternative 3—Process with Plutonium Separation

DOE analyzed one technology for processing sludge residues that involves plutonium separation: acid dissolution followed by plutonium oxide recovery. A quantitative analysis of the impacts of implementing this technology was conducted for Rocky Flats. Any plutonium separated under this alternative would be disposed of using an immobilization process.

- **Acid Dissolution/Plutonium Oxide Recovery—**Recovery of plutonium from sludges (except greases and oily sludges) by acid dissolution would consist of dissolving the material in nitric acid followed by precipitation of the plutonium with oxalic acid. The feed material would be size-reduced to a powder or granular material, which would be introduced into the dissolver using a screw feeder. The dissolver would be charged with 7.5 molar nitric acid, which would recirculate within the dissolver column. The dissolver would be sparged (agitated) with air to prevent settling of solids and to provide intimate contact between solids and acids.

  The plutonium dissolved in the process would be mixed with a solution of oxalic acid, causing the plutonium to precipitate as plutonium oxalate. The slurry would be filtered through a stainless steel filter boat and washed with dilute nitric acid. Magnesium hydroxide would be added to the precipitation filtrate to precipitate any remaining plutonium. This material would then be filtered, calcined at 450 °C (840°F), packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP. The plutonium oxalate filter cake on the stainless steel filter boat would be placed in a calcining furnace and heated to 450°C (840°F) for four hours, thereby decomposing the oxalate, evaporating entrained water into the glovebox atmosphere, and leaving a dry plutonium oxide cake. After cooling, the plutonium oxide would be removed from the filter boat, sampled, weighed, and packaged for temporary storage. The plutonium oxide would then be thermally stabilized, packaged according to DOE-STD-3013-96 (DOE 1996f) requirements, and placed in interim storage pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition EIS (DOE 1997c). This process is considered to be a proven technology.

2.4.6.4 Alternative 4—Combination of Processing Technologies

DOE analyzed two processing technologies: repackage at Rocky Flats for sludge residues having IDCs 089, 099, and 332 and filter/dry at Rocky Flats for all other sludge residues. A description of these materials may be found in Section B.3.5 of Appendix B. In the No Action Alternative, all sludge residues were analyzed together and were assumed to be wet; however, DOE has determined that the material in the three IDCs are not wet. Therefore, they only require repackaging for stabilization. The analyses were based on application of a variance to the safeguards termination limit for a maximum 10 percent plutonium concentration. To ensure that all materials would be below the 10 percent plutonium concentration limit, high plutonium concentration material would be blended with low plutonium concentration material having the same IDC or with an inert material.

- **Filter/Dry—**This is the same technology described under the No Action Alternative in Section 2.4.6.1. DOE would apply a variance to the safeguards termination limit for the sludge residues (except IDCs 089, 099, and 332). After filtration and drying, the stabilized residue would be placed in short-term storage pending disposal at WIPP as transuranic waste.

- **Repackaging—**This technology would apply to all sludge residues with IDCs 089, 099, and 332. The material would be repacked to meet the WIPP waste acceptance criteria and the 10 percent plutonium variance to the safeguards termination limit, then placed in short-term storage pending disposal at WIPP as transuranic waste.

2.4.7 Management of Glass Residues

This category is composed of Raschig rings and other miscellaneous glass residues. Raschig rings are hollow borosilicate glass cylinders that are 3.8 cm (1.5 in) long by 3.8 cm (1.5 in) diameter and 0.48 cm (0.19 in) thick. They are used to absorb neutrons and thus prevent criticality in large process tanks. Over time, the rings become coated with insoluble plutonium compounds. Some of the glass residues at Rocky Flats have Resource Conservation and Recovery Act hazardous waste designations that are acceptable at WIPP in materials to be disposed of as transuranic waste. [See Table 3.4.2.3-2 of the WIPP Waste Acceptance Criteria, Revision 5 (DOE 1996j).] The total quantity of glass residues at Rocky Flats needing processing is approximately 135 kg (300 lb) and includes approximately 5 kg (11 lb) of plutonium. The technology/site options analyzed for processing these materials are shown in **Figure 2–9**. The impacts associated with the management of glass residues are presented in Table 2–23 and Section 4.8.

DOE's preferred processing technology for glass residues is stabilization by neutralization and drying (Alternative 4) because implementation of a variance would allow Rocky Flats to process the material most expeditiously and close the site. Large items would be size-reduced to facilitate washing, and any fines would be stabilized by cementation or repackaging. This is the technology described for glass residues in the Rocky Flats Solid Residue Environmental Assessment (DOE 1996k).

2.4.7.1 Alternative 1—No Action—Stabilize and Store

- ❒ **Neutralize/Dry—**The process assumed for stabilizing glass residues in the No Action Alternative is the same as the Neutralize/Dry process described in Section 2.4.3.1 for aqueous-contaminated combustible residues. Larger items would be size-reduced to facilitate washing. The materials would be washed with a neutralizing solution; excess liquid would be filtered off; and the remaining residues would be dried either by mixing with an absorbent material or by heating at low temperatures and then repackaged for interim storage pending disposition. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. The washing solution would be periodically withdrawn, assayed for plutonium content, and sent to the liquid waste treatment facility in Building 374.

2.4.7.2 Alternative 2—Process without Plutonium Separation

DOE analyzed three technologies for processing glass residues that do not involve plutonium separation: vitrification, blend down with inert materials to the safeguards termination limits, and sonic wash. Quantitative analyses of implementing these technologies at Rocky Flats were conducted.

- ❒ **Vitrification—**Because these residues are composed of various forms of glass, they are readily vitrified. The technology that would be used at Rocky Flats is vitrification in a furnace, as described for ash residues in Section 2.4.1.2.

- ❒ **Blend Down—**The residues would be moved to Module B, Building 707, at Rocky Flats and bagged into the glovebox. Then the residues would be unpacked, size-reduced as necessary, diluted by mixing with inert materials (including an absorbent to dry any free liquids), packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP.

❑ **Sonic Wash—**The sonic wash process for glass residues is the same as the process described for combustibles in Section 2.4.3.2.

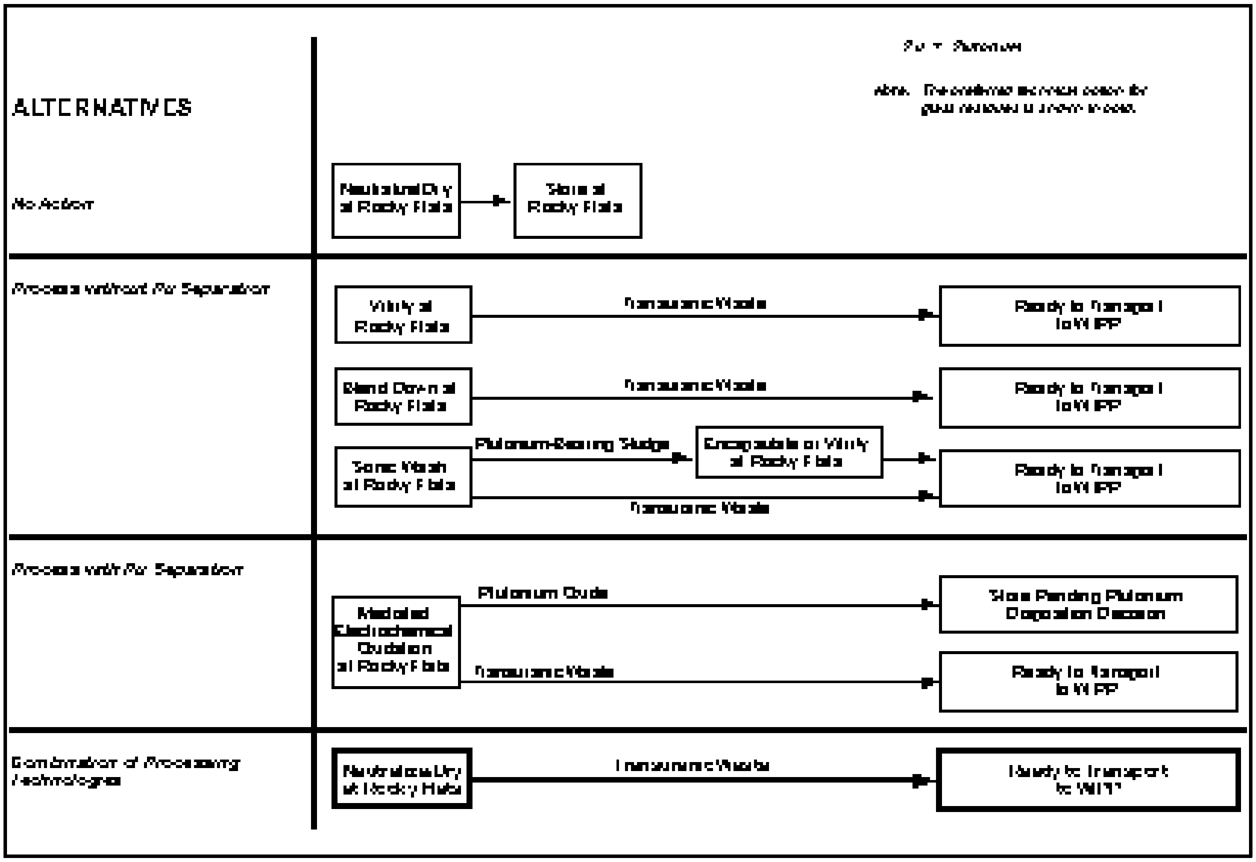

Figure 2–9 Processing Technologies for Glass Residues

2.4.7.3 Alternative 3—Process with Plutonium Separation

DOE analyzed mediated electrochemical oxidation for processing of glass residues with plutonium separation at Rocky Flats. A quantitative analysis of the impacts of implementing this technology was conducted for Rocky Flats. Any plutonium separated under this alternative would be disposed of using an immobilization process.

❑ **Mediated Electrochemical Oxidation—**This technology was described previously in Section 2.4.3.3. Plutonium dissolved in the process would be precipitated as an oxalate and then calcined to plutonium oxide. The oxides would be thermally stabilized, packaged according to DOE-STD-3013-96 (DOE 1996f), and placed in interim storage pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition EIS (DOE 1997c). Any other solid residues would be dried, stabilized, packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP.

2.4.7.4 Alternative 4—Combination of Processing Technologies

DOE analyzed neutralize/dry at Rocky Flats as the only processing technology for glass residues under this alternative. The analysis was based on application of a variance to the safeguards termination limit for a maximum 10 percent plutonium concentration. To ensure that all materials would be below the 10 percent plutonium concentration limit, high plutonium concentration material would be blended with low plutonium concentration material having the same IDC or with an inert material.

- ❒ **Neutralize/Dry—**This is the same stabilization technology described under the No Action Alternative in Section 2.4.7.1. DOE would apply a variance to the safeguards termination limit for these materials. Accordingly, after neutralization and drying, the stabilized residue would be repackaged and placed in short-term storage pending disposal at WIPP as transuranic waste.

2.4.8 Management of Graphite Residues

The graphite residues generated during foundry operations at Rocky Flats are solid pieces of graphite from broken and intact molds. Some of the graphite residues at Rocky Flats have Resource Conservation and Recovery Act hazardous waste designations that are acceptable at WIPP in materials to be disposed of as transuranic waste. [See Table 3.4.2.3-2 of the WIPP Waste Acceptance Criteria, Revision 5 (DOE 1996j).] The total quantity of graphite needing processing is approximately 1,880 kg (4,140 lb), including approximately 97 kg (215 lb) of plutonium. The technology/site options analyzed for processing graphite residues are shown in **Figure 2–10**. The impacts associated with the management of graphite residues are presented in Table 2–24 and Section 4.9.

DOE's preferred processing technology for graphite residues is to repackage (Alternative 4) because implementation of a variance to the safeguards termination limit would allow Rocky Flats to process the material most expeditiously and close the site. This is the processing described for graphite residues in the Rocky Flats Solid Residue Environmental Assessment (DOE 1996k).

2.4.8.1 Alternative 1—No Action—Stabilize and Store

- ❒ **Repackage—**Graphite residues would be directly repackaged into metal containers meeting interim safe storage criteria. After repackaging, the residue containers would be sent to an appropriate storage area for interim storage pending disposition. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period.

2.4.8.2 Alternative 2—Process without Plutonium Separation

DOE analyzed three technologies for processing graphite residues that do not involve plutonium separation: cementation, vitrification, and blend down with inert materials to the safeguards termination limits. Quantitative analyses of implementing these technologies at Rocky Flats were conducted.

- ❒ **Immobilization (Cementation)—**The graphite residues would be size-reduced, cemented, packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP. The process is considered to be a proven technology.

- ❒ **Immobilization (Vitrification)—**In the Rocky Flats furnace vitrification process, the graphite residues would be placed in Module E, Building 707. The residues would be unpacked, sorted, size-reduced (as necessary), and measured into 2-l (0.5-gal) cans. The amount of material added to the cans would be limited to 83.5 g (0.18 lb) plutonium per can. The residues would be calcined before vitrification to prevent off-gases from combusting during vitrification. Glass frit would be added until the resulting material would be below the safeguards termination limits for vitrified material. The mixture would then be melted to form a glass. After cooling, the cans of vitrified material would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP. This process is considered to be proven technology. Activities are underway to optimize the process and reduce the steps necessary to achieve an acceptable waste form.

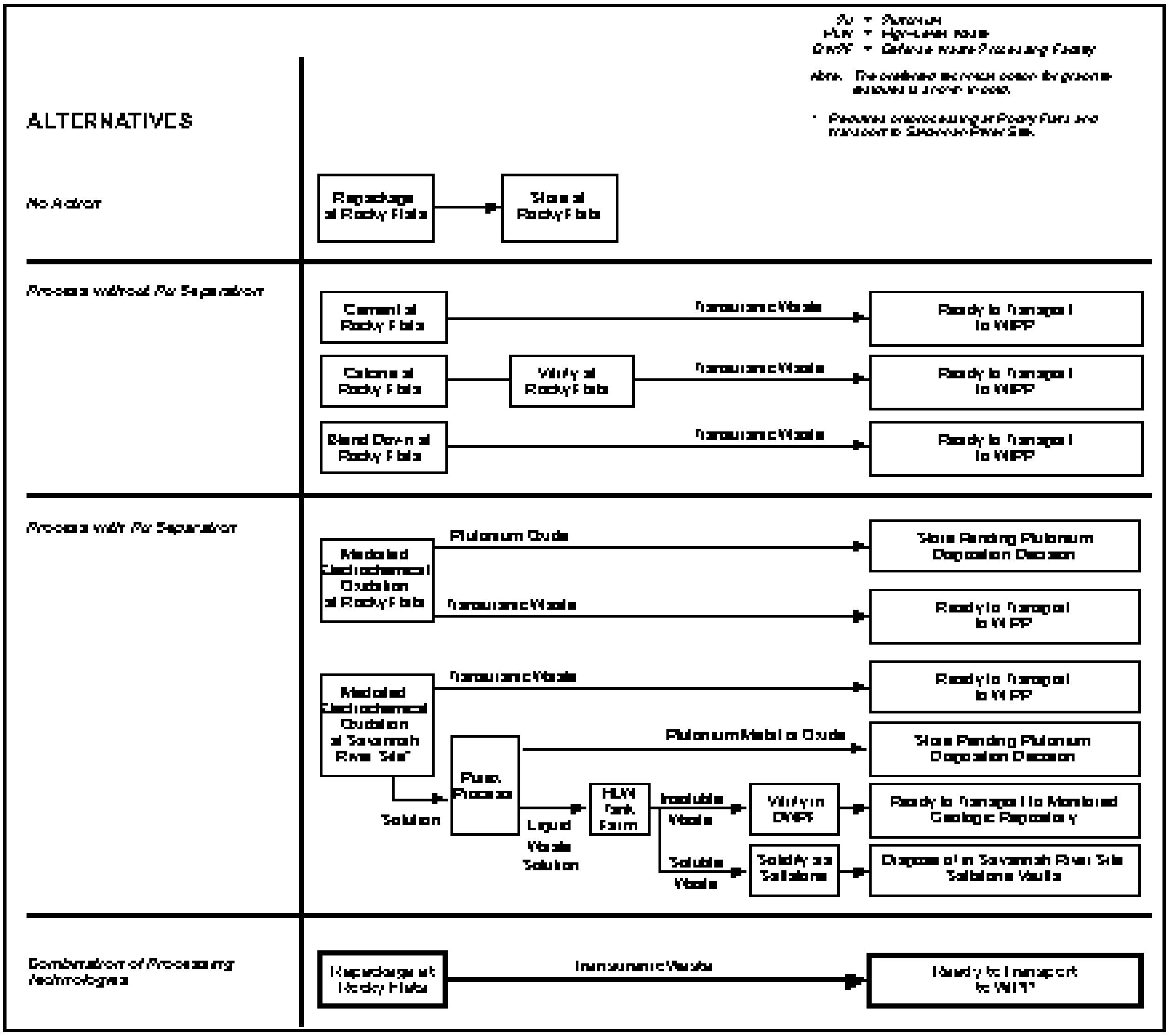

Figure 2–10 Processing Technologies for Graphite Residues

- **Blend Down—**The plutonium concentration in graphite residues would be decreased by blending with an inert material for disposal at WIPP without further processing. The residues first would be moved to Module B, Building 707, and bagged into the glovebox. The residues would be unpacked, size-reduced as necessary, diluted by mixing with an inert material, packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP.

2.4.8.3 Alternative 3—Process with Plutonium Separation

DOE analyzed mediated electrochemical oxidation as the only technology for processing graphite residues with plutonium separation. Quantitative analysis of the impacts of implementing this technology were conducted for Rocky Flats and the Savannah River Site. Any plutonium separated under this alternative would be disposed of using an immobilization process.

❒ **Mediated Electrochemical Oxidation—**At both Rocky Flats and the Savannah River Site, plutonium would be dissolved using the silver(II) ion to oxidize the plutonium. Any remaining insoluble material would be removed by filtration, dried and packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP. The plutonium-bearing solution, however, would be treated differently at the two sites. At Rocky Flats, the plutonium would be precipitated as plutonium oxalate, then calcined to plutonium oxide. At the Savannah River Site, the plutonium-bearing solution would be further treated using the Purex process to produce plutonium metal or oxide. These processes were previously described in Section 2.4.3.3 and Section 2.4.1.3 for Rocky Flats and the Savannah River Site, respectively. In both cases, the plutonium metal or plutonium oxide would be thermally stabilized, packaged according to DOE-STD-3013-96 (DOE 1996f), and placed in interim storage pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition EIS (DOE 1997c).

2.4.8.4 Alternative 4—Combination of Processing Technologies

DOE analyzed repackaging at Rocky Flats as the only processing technology for graphite residues under this alternative. The analysis was based on application of a variance to the safeguards termination limit for a maximum 10 percent plutonium concentration. To ensure that all materials would be below the 10 percent plutonium concentration limit, high plutonium concentration material would be blended with low plutonium concentration material having the same IDC, or with an inert material.

❒ **Repackaging—**This is the same technology described under the No Action Alternative in Section 2.4.8.1. DOE would apply a variance to the safeguard termination limit for these materials. Accordingly, after repackaging, the residue would be placed in short-term storage pending disposal at WIPP as transuranic waste.

2.4.9 Management of Inorganic (Metal and Others) Residues

Inorganic residues are solids (e.g., metals, ceramics, and oxides) used during production operations that do not have any combustible components. Some of the inorganic residues at Rocky Flats have a Resource Conservation and Recovery Act hazardous waste designation that is acceptable at WIPP in materials to be disposed of as transuranic waste. [See Table 3.4.2.3-2 of the WIPP Waste Acceptance Criteria, Revision 5 (DOE 1996j).] The total quantity of inorganic residues needing processing is approximately 460 kg (1,000 lb) and includes approximately 18 kg (40 lb) of plutonium. The technology/site options analyzed for processing inorganic residues are shown in **Figure 2–11**. The impacts associated with the management of inorganic residues are given in Table 2–25 and Section 4.10.

DOE's preferred processing option for inorganic (metal and other) residues is repackaging without further processing and the application of a variance to the safeguards termination limit for the stabilized residues (Alternative 4) because implementation of variances would allow Rocky Flats to process the materials most expeditiously and close the site. This is the process described for inorganic residues in the Rocky Flats Solid Residue Environment Assessment (DOE 1996k).

2.4.9.1 Alternative 1—No Action—Stabilize and Store

❒ **Repackage—**These residues would be repackaged into metal containers meeting interim safe storage criteria. After repackaging, the residue containers would be sent to an appropriate storage area for interim storage pending disposition. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period.

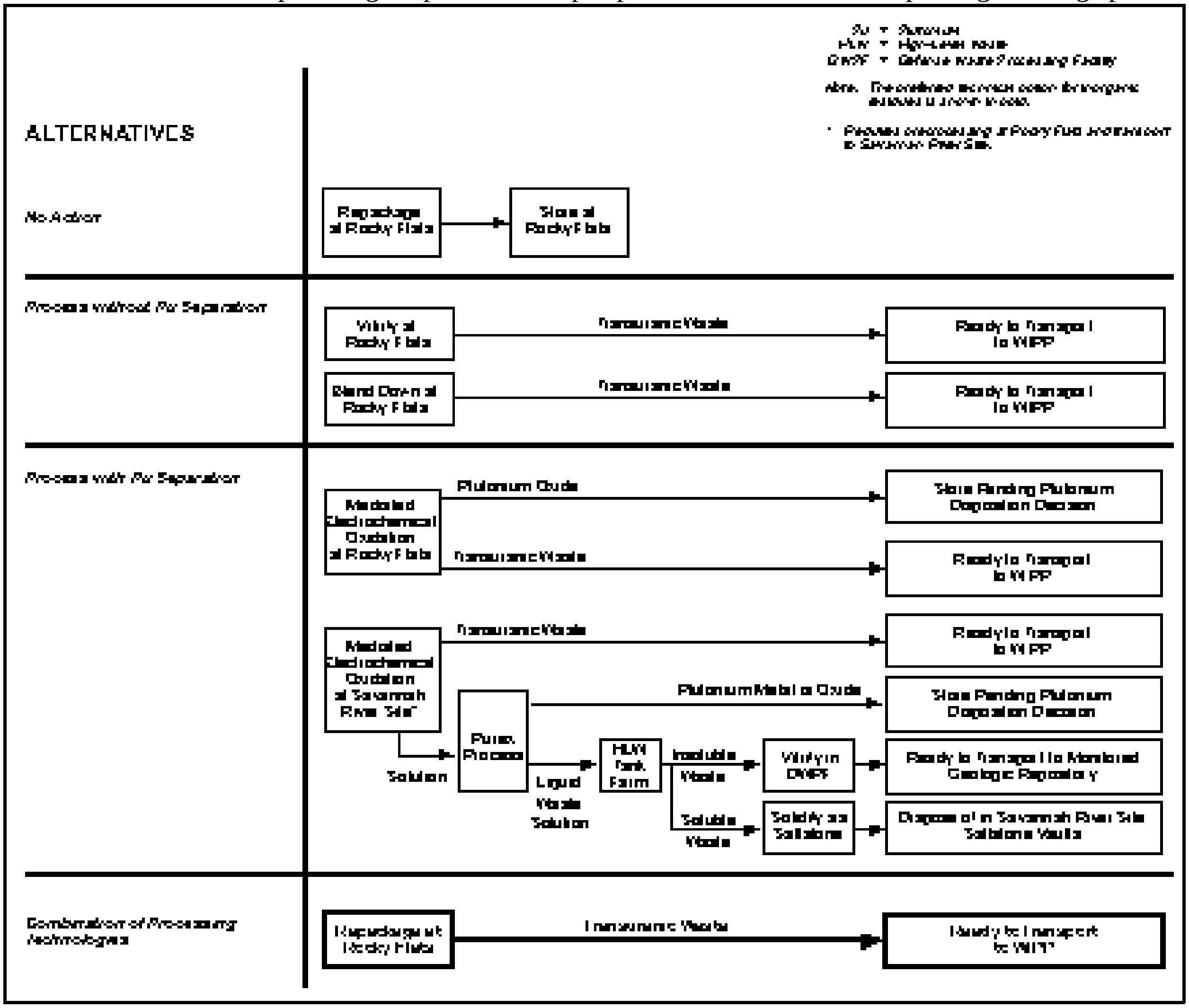

Figure 2–11 Processing Technologies for Inorganic Residues

2.4.9.2 Alternative 2—Process without Plutonium Separation

DOE analyzed two technologies that do not involve plutonium separation for processing inorganic residues: vitrification and blend down with inert materials to the safeguards termination limits. Quantitative analyses of these technologies at Rocky Flats were conducted.

- ❒ **Immobilization (Vitrification)—**In the vitrification process, the residues would be placed in Module E, Building 707, unpacked, sorted, size-reduced (as necessary), and weighed into 8.2-L (2.2-gal) cans. The amount of material added to the cans would be limited to 83.5 g (0.18 lb) of plutonium per can, the maximum permissible for shipment to WIPP. Glass frit would be added to the cans until the resulting material reaches the safeguards termination limit for vitrified material. The mixture then would be melted and encapsulated in glass. After cooling, the vitrified ash would be packaged according to the WIPP waste acceptance criteria and placed in interim storage pending disposal at WIPP. The process is considered to be a proven technology. Activities are underway to optimize the process and reduce the steps necessary to achieve an acceptable waste form.

- ❒ **Blend Down—**The plutonium concentration of the residues would be decreased by blending with an inert material for disposal at WIPP without further processing. The residues would be moved to Module B, Building 707, and bagged into the glovebox. Then the residues would be unpacked, size-reduced as necessary, diluted by mixing with an inert material (including an absorbent to dry any free liquids), packaged according to the WIPP waste acceptance criteria, and placed in interim storage pending disposal at WIPP.

2.4.9.3 Alternative 3—Process with Plutonium Separation

DOE analyzed mediated electrochemical oxidation as the only technology for processing inorganic residues with plutonium separation. Quantitative analyses of the impacts of implementing this technology at Rocky Flats and the Savannah River Site were conducted. Any plutonium separated under this alternative would be disposed of using an immobilization process.

- ❒ **Mediated Electrochemical Oxidation—**This process was described previously in Section 2.4.3.3 and Section 2.4.1.3 for Rocky Flats and the Savannah River Site, respectively.

2.4.9.4 Alternative 4—Combination of Processing Technologies

DOE analyzed repackaging at Rocky Flats as the only processing technology for inorganic (metal and other) residues under this alternative. The analysis was based on application of a variance to the safeguards termination limit for a maximum 10 percent plutonium concentration. To ensure that all materials would be below the 10 percent plutonium concentration limit, high plutonium concentration material would be blended with low plutonium concentration material having the same IDC, or with an inert material.

- ❒ **Repackaging—**This is the same technology described under the No Action Alternative in Section 2.4.9.1. DOE would apply a variance to the safeguards termination limit for these materials. After repackaging, the residue would be placed in short-term storage pending disposal at WIPP as transuranic waste.

2.4.10 Management of Scrub Alloy

Scrub alloy is a solid metal mixture of magnesium, aluminum, americium, and plutonium that was generated during the salt scrub processing of molten salt extraction salts and the anode alloy processing of electrorefining anode heels. Some of the scrub alloy is from developmental programs and contains calcium/gallium or calcium/cerium. The total quantity of scrub alloy at Rocky Flats needing processing is approximately 700 kg (1,540 lb), including approximately 200 kg (440 lb) of plutonium. The processing technology/site options analyzed for scrub alloy are shown in **Figure 2–12**. The impacts associated with the management of scrub alloy are presented in Table 2–26 and Section 4.11.

DOE has identified the Purex process at the Savannah River Site as the preferred processing technology for scrub alloy because this would allow the material to be processed remotely, resulting in lower radiation exposure to the workers and thus providing health and safety benefits. The Purex process is the traditional methodology for processing scrub alloy from Rocky Flats.

2.4.10.1 Alternative 1—No Action—Stabilize and Store

- **Continued Storage (Repackage as Necessary)**—In the No Action Alternative, scrub alloy would continue to be stored in vaults at Rocky Flats until a suitable disposition was determined. The material would be monitored for leaks and deterioration of the packaging. As repackaging becomes necessary, the drums would be unpacked, and the packages would be entered into a glovebox where the scrub alloy buttons would be placed in new cans. The cans would be removed from the glovebox and placed in new drums for safe, secure storage until a final disposition decision was made by DOE. As there is no basis for estimating how long the scrub alloy might have to remain in storage before a disposition mechanism would be identified, DOE has analyzed in this EIS the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period.

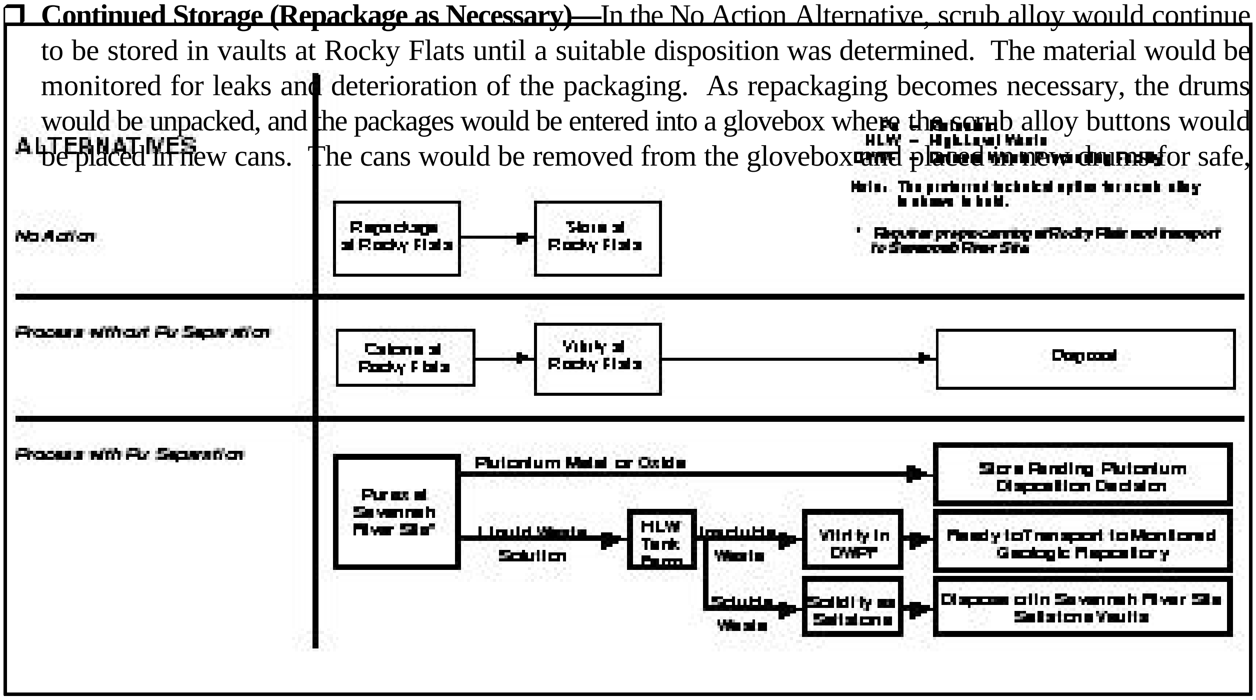

Figure 2–12 Processing Technologies for Scrub Alloy

2.4.10.2 Alternative 2—Process without Plutonium Separation

DOE analyzed calcination of scrub alloy followed by vitrification for processing of scrub alloy without plutonium separation. Quantitative analysis of the impacts of implementing this technology was conducted at Rocky Flats.

- **Calcination/Vitrification**—The vitrification process proposed by Rocky Flats for scrub alloy requires two steps. First, the scrub alloy would be converted to an oxide by burning and calcining at 600°C (1,110°F) and 1,000°C (1,830°F), respectively. Next, the calcined material would be blended with sufficient glass frit to make a product that would satisfy the safeguards termination limits, then heated in a furnace to a temperature of 700 to 1,300°C (1,290 to 2,370°F). The end product would consist of a vitrified monolith containing less than 5 percent plutonium. After processing, material would be packaged and placed in interim storage pending disposal or other disposition.

  Because calcination of powdered or granular materials in muffle furnaces is considered to be a proven technology and plutonium metals and other alloys have been routinely burned in the past, calcination of scrub alloy is considered to be a low-risk technology, although it has not been specifically proven in this context. The vitrification process of fusing the metal oxide with glass frit in a muffle furnace to form a nonuniform, amorphous, encapsulated product should be identical to the vitrification process described for other materials in this EIS.

This disposition of scrub alloy through a calcination and vitrification process was not envisioned as a disposal approach during the development of the WIPP Supplemental EIS-II (DOE 1997a) and, therefore, scrub alloy was not included in the WIPP Baseline Inventory Report. Further NEPA review would be needed for disposal of the transuranic waste generated from this particular processing of the scrub alloy. In the event that this technology was implemented, the resulting material (although of satisfactory composition and form) might be subject to disposal delays because of the necessity to revise regulatory documentation. Because this material has historically been considered to be "War Reserve" material, its final disposition to WIPP has not been programmatically evaluated. This calcination/vitrification, although technically viable, is not a desirable processing technology for scrub alloy at Rocky Flats because of the large quantity of transuranic waste that would be generated and because disposal of material generated by this process was not analyzed in the WIPP Supplemental EIS-II (DOE 1997a). An estimate of the impacts of transporting the transuranic wastes generated from the calcination/vitrification process to WIPP is presented in Appendix E, Section E.6.5 of this EIS.

2.4.10.3 Alternative 3—Process with Plutonium Separation

DOE analyzed the Purex process for processing scrub alloy with plutonium separation. A quantitative analysis of the impacts of implementing this technology at the Savannah River Site was conducted. Any plutonium separated under this alternative would be disposed of using an immobilization process.

- **Purex Process—**Scrub alloy would be packaged for shipment at Rocky Flats and shipped to the Savannah River Site. At the Savannah River Site, the scrub alloy would be received at the 235-F Storage Facility and transferred to a canyon facility, where it would be dissolved in nitric acid. The solution would be processed through a finishing line as with other stabilization processes. The product would be plutonium metal or oxide that would be thermally stabilized, packaged according to DOE-STD-3013-96 (DOE 1996f), and placed in interim storage in the FB-Line vaults (or in the Actinide Packaging and Storage Facility when completed), pending disposition in accordance with decisions to be reached under the Surplus Plutonium Disposition EIS (DOE 1997c). The Purex process is considered to be a proven technology at the Savannah River Site.

2.4.10.4 Alternative 4—Combination of Processing Technologies

DOE has not analyzed any technology under this alternative for scrub alloy.

2.5 STRATEGIC MANAGEMENT APPROACHES

In addition to evaluating the alternatives for management of the plutonium residues and scrub alloy for each individual material category, as discussed in Section 2.4, DOE has also evaluated several "Strategic Management Approaches." These approaches involve the compilation of a complete set of processing options which allows a specific management criterion to be met. Constructing these Strategic Management Approaches allows presentation of the environmental impacts of the proposed action as one set of numbers, instead of several different sets of numbers representing the impacts from management of each of the different material categories individually.

In constructing these Strategic Management Approaches, DOE is not necessarily suggesting that any of them, other than the Preferred Alternative, would be implemented. Rather, DOE recognizes that there is a very large number of combinations of material category, processing technology, and management site that could be constructed— too many to individually analyze and present in an understandable manner in this EIS. Rather than trying to present all of the combinations that could be generated, DOE has developed a subset of eight of the total number of possible combinations that illustrate the range of approaches that might be utilized. The themes addressed in this subset of Strategic Management Approaches are:

- No Action—Stabilize and Store
- Preferred Alternative
- Minimizing Total Process Duration at Rocky Flats
- Minimize Cost
- Conduct all Processing at Rocky Flats
- Conduct the Fewest Actions at Rocky Flats
- Selection of Processes Yielding the Greatest Amount of Plutonium Separation
- Selection of Processes without Plutonium Separation.

The specific material category/technology/site combinations that were used to construct each of the Strategic Management Approaches listed above are specified in Tables 2–2 through 2–4.

The environmental impacts that would result from implementation of each of the Strategic Management Approaches were obtained by summing the impacts that would occur due to each of the individual material category/technology/site combinations used to construct a particular alternative or approach. A similar process could be used to determine the impacts of any other Strategic Management Approach that a reader might wish to consider. Comparison of the impacts that would result from these various Strategic Management Approaches allow the reader to evaluate the sensitivity of the impacts to the major characteristics (e.g., cost, location of processing, plutonium separation vs. no separation, etc.) around which the Strategic Management Approaches were constructed.

The environmental impacts that would result from implementation of the eight Strategic Management Approaches are presented in Table 2–27 and in Section 4.22. The technologies and sites considered for each material category are described in detail in Sections 2.4.1 through 2.4.10.

In considering these Strategic Management Approaches, DOE requests the reader to keep in mind they are illustrative and are not intended necessarily to be the set of material category/technology/site combinations that would be selected in the Records of Decision. Rather, DOE expects that it will be more appropriate to determine what action to take, if any, by selecting the approach individually for each material category and then assembling these choices as the action to implement. This sort of selection is in fact presented in the Preferred Alternative, which is presented as one of the Strategic Management Approaches.

The strategic management approaches are discussed in more detail below.

2.5.1 No Action Alternative—Stabilize and Store

The stabilization technologies that represent the No Action Alternative are those analyzed in the Solid Residue Environmental Assessment (DOE 1996k). The stabilization of scrub alloy was not addressed in the Solid Residue Environmental Assessment. The No Action Alternative for scrub alloy is continued storage at Rocky Flats with repackaging, as necessary. Some of the materials may be subjected to more than one processing technology conducted in series (e.g., some of the incinerator ash may be calcined and then cemented or repackaged). For the purpose of analysis, all materials in the No Action Alternative are assumed to be stored for 20 years after stabilization. The material categories and the stabilization technologies used for the No

Action Alternative are listed in **Table 2–2** and are also discussed in the sections for each material category, Sections 2.4.1 through 2.4.10. All of the stabilization activities would occur at Rocky Flats.

Table 2–2 Stabilization Technology Used in No Action—Stabilize and Store for Each Material Category

Material	*No Action—Stabilize and Store Alternative*
Incinerator ash residues	Calcination followed by cementation or repackaging
Sand, slag, and crucible residues	Calcination followed by cementation or repackaging
Graphite fines residues	Calcination followed by cementation or repackaging
Inorganic ash residues	Calcination followed by cementation or repackaging
Molten salt extraction/electrorefining salt residues	Pyro-oxidation
Direct oxide reduction salt residues	Pyro-oxidation
Aqueous-contaminated combustible residues	Neutralize/dry
Organic-contaminated combustible residues	Wash/thermal desorption/steam passivation
Dry combustible residues	Repackage
Plutonium fluoride residues	Acid dissolution/process to plutonium oxide
High-efficiency particulate air filter media residues	Neutralize/dry
Ful Flo filter media residues	Neutralize/dry
Sludge residues	Filter/dry
Glass residues	Neutralize/dry
Graphite residues	Repackage
Inorganic (metal and others) residues	Repackage
Scrub alloy	Repackage

2.5.2 Preferred Alternative

DOE has identified a preferred processing technology for each of the Rocky Flats plutonium residues and scrub alloy material categories. The material categories and DOE's Preferred Alternative are listed in **Table 2–3** and are also discussed in the sections for each material category, in Section 2.4, including DOE's reasons for selecting these processing technologies.

DOE's Preferred Alternative includes processing technologies for several material categories that would involve separation of plutonium from the materials as plutonium metal or oxide at either the Savannah River Site or Los Alamos National Laboratory. These sites have unique facilities and processing expertise for separating plutonium from certain categories of the residues and scrub alloy that are not available at Rocky Flats. The processing technologies involving separation are proposed not only because they will allow DOE to stabilize the residues and scrub alloy (to address near-term health and safety issues associated with storage of the materials), and would convert the materials into forms that would allow their disposal or other disposition (thus eliminating the continuing health and safety risks that would be associated with their continued storage), but would also address health and safety concerns related to the increased worker radiation doses associated with the non-separation processing technologies for these categories of residues and scrub alloy. The Savannah River Site facilities for the separation of plutonium include the H-Canyon, HB-Line, F-Canyon, and the FB-Line. Use of these facilities, some of which are designed for remote operation, would result in lower worker radiation exposure than use of the glovebox facilities at Rocky Flats, low technical uncertainty, or low cost. Separation of plutonium from pyrochemical salt residues at Los Alamos National Laboratory would not be remote-handled, but would involve much shorter time exposures of the workers to the residues than would the nonseparation technology. Any plutonium separated would be disposed of using an immobilization process.

Table 2–3 Preferred Processing Technology and Site for Each Material Category

Material Category	*Preferred Alternative (Draft EIS)*	*Preferred Alternative (Final EIS)*
Ash Residues		
Incinerator Ash	Vitrification at Rocky Flats (see Section 2.4.1 of Draft EIS)	Repackage at Rocky Flats (Alternative 4) (see Section 2.4.1)
Sand, Slag and Crucible	Preprocess at Rocky Flats and Purex Process at the Savannah River Site (see Section 2.4.1 of Draft EIS)	Preprocess at Rocky Flats and Purex Process at the Savannah River Site (Alternative 3) (see Section 2.4.1)
Graphite Fines	Vitrification at Rocky Flats (see Section 2.4.1 of Draft EIS)	Repackage at Rocky Flats (Alternative 4) (see Section 2.4.1)
Inorganic	Vitrification at Rocky Flats (see Section 2.4.1 of Draft EIS)	Repackage at Rocky Flats (Alternative 4) (see Section 2.4.1)
Pyrochemical Salt Residues		
Molten Salt Extraction/Electrorefining (IDC 409 Only)	Salt Distillation at Rocky Flats (see Section 2.4.2 of Draft EIS)	Repackage at Rocky Flats (Alternative 4) (see Section 2.4.2)
Molten Salt Extraction/Electrorefining (All Others)	Salt Distillation at Rocky Flats (See Section 2.4.2 of Draft EIS)	Repackage at Rocky Flats (Alternative 4) (See Section 2.4.2)
Direct Oxide Reduction (IDCs 365, 413, 417, and 427)	Pyro-oxidation at Rocky Flats and Water Leach at Los Alamos National Laboratory (See Section 2.4.2 of Draft EIS) (No Action for some)	Preprocess at Rocky Flats and Acid Dissolution/Plutonium Oxide Recovery at Los Alamos National Laboratory (Alternative 3) and Repackage at Rocky flats (Alternative 4) (See Section 2.4.2)[a]
Direct Oxide Reduction (All Others)	Pyro-oxidation at Rocky Flats and Water Leach at Los Alamos National Laboratory (See Section 2.4.2 of Draft EIS) (No Action for some)	Repackage at Rocky Flats (Alternative 4) (See Section 2.4.2)
Combustible Residues		
Aqueous-Contaminated	Neutralize/Dry at Rocky Flats (See Section 2.4.3 of Draft EIS)	Neutralize/Dry at Rocky Flats (Alternative 4) (See Section 2.4.3)
Organic-Contaminated	Thermal Desorption/Steam Passivation at Rocky Flats (see Section 2.4.3 of Draft EIS)	Thermal Desorption/Steam Passivation at Rocky Flats (Alternative 4) (see Section 2.4.3)
Dry	Repackage at Rocky Flats (see Section 2.4.3 of Draft EIS)	Repackage at Rocky Flats (Alternative 4) (see Section 2.4.3)
Plutonium Fluoride Residues		
Plutonium Fluoride	Preprocess at Rocky Flats and Purex Process at the Savannah River Site (see Section 2.4.4 of the Draft EIS)	Preprocess at Rocky Flats and Purex Process at the Savannah River Site (Alternative 3) (see Section 2.4.4)
Filter Media Residues		
Ful Flo Filter Media (IDC 331)	To be determined	Blend Down at Rocky Flats (Alternative 2) (see Section 2.4.5)
High-Efficiency Particulate Air Filter Media (IDC 338)	To be determined	Neutralize/Dry at Rocky Flats (Alternative 4) (see Section 2.4.5)
High-Efficiency Particulate Air Filter Media (All Others)	To be determined	Repackage at Rocky Flats (Alternative 4) (see Section 2.4.5)
Sludge Residues		
(IDCs 089, 099, and 332)	To be determined	Repackage at Rocky Flats (Alternative 4) (see Section 2.4.6)

Material Category	Preferred Alternative (Draft EIS)	Preferred Alternative (Final EIS)
All Other Sludges	To be determined	Filter/Dry at Rocky Flats (Alternative 4) (see Section 2.4.6)
Glass Residues		
Glass	Neutralize/Dry at Rocky Flats (see Section 2.4.7 of Draft EIS)	Neutralize/Dry at Rocky Flats (Alternative 4) (see Section 2.4.7)
Graphite Residues		
Graphite	Repackage at Rocky Flats (see Section 2.4.8 of Draft EIS)	Repackage at Rocky Flats (Alternative 4) (see Section 2.4.8)
Inorganic (Metal and Other) Residues		
Inorganic (Metal and Other)	Repackage at Rocky Flats (see Section 2.4.9 of Draft EIS)	Repackage at Rocky Flats (Alternative 4) (See Section 2.4.9)
Scrub Alloy		
Scrub Alloy	Preprocess at Rocky Flats and Purex Process at the Savannah River Site (see Section 2.4.10 of Draft EIS)	Preprocess at Rocky Flats and Purex Process at the Savannah River Site (Alternative 3) (see Section 2.4.10)

[a] There are two preferred processing technologies for the high plutonium concentration direct oxide reduction salt residues (IDCs 365, 413, 417, and 427). The rationale for having two preferred processing technologies is given in Section 2.4.2.

2.5.3 Other Management Approaches

In addition to the No Action Alternative and the Preferred Alternative, DOE constructed six other illustrative combinations of selected technologies and sites for each residue and scrub alloy material category as examples of strategic approaches. While these combinations represent a range of reasonable strategic approaches, it is important to recognize that these are only six of a myriad of approaches that could have been constructed for the materials subject to this EIS. The combinations of technologies and sites were chosen to illustrate approaches that emphasize the following:

- Minimize total process duration at Rocky Flats
- Minimize cost
- Conduct all processing at Rocky Flats
- Conduct fewest actions at Rocky Flats
- Select processes yielding the greatest amount of plutonium separation
- Select processes without plutonium separation

The processing technologies and sites for each material category used to construct each alternative are shown in **Table 2–4**.

2.6 STORAGE METHODS AND ISSUES

In this EIS, storage is considered for two categories of materials: (1) plutonium residues and scrub alloy and (2) plutonium metal and oxides. Transuranic waste generated by the processing of plutonium residues and scrub alloy at Rocky Flats would be stored in approved storage facilities until this waste is shipped to WIPP for disposal. These facilities would have to be maintained until WIPP is available for accepting Rocky Flats transuranic waste. A delay in opening WIPP may delay the closure of these facilities and the Rocky Flats site. Furthermore, a delay in opening WIPP for disposal operations may cause Rocky Flats to run out of transuranic waste storage capacity and require construction of additional storage capacity. Other processing sites would

Table 2–4 Selected Management Approaches for Processing Rocky Flats Plutonium Residues and Scrub Alloy

Material Category	*Minimize Total Process Duration at Rocky Flats*[a]	*Minimize Cost*	*Conduct All Processes at Rocky Flats*	*Conduct Fewest Actions at Rocky Flats*[b]	*Process with Maximum Plutonium Separation*	*Process without Plutonium Separation*
Incinerator Ash Residues*	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Preprocess at Rocky Flats and MEO at SRS (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
Sand, Slag and Crucible Residues*	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Preprocess at Rocky Flats and Purex at SRS (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
Graphite Fines Ash Residues*	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Preprocess at Rocky Flats and MEO at SRS (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
Inorganic Ash Residues*	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4) [c]	Repackage at Rocky Flats (Alternative 4)
MSE/ER Salt Residues* (IDC 409)	Repackage at Rocky Flats (Alternative 4)	Salt Distill at Rocky Flats (Alternative 3)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Preprocess at Rocky Flats and Salt Distill at LANL (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
MSE/ER Salt Residues (All Others)*	Salt Scrub at Rocky Flats and Purex at SRS (Alternative 3)	Salt Distill at Rocky Flats (Alternative 3)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Salt Distill at Rocky Flats (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
DOR Salt Residues (IDCs 365, 413, 417, and 427)*	Preprocess at Rocky Flats and Acid Dissolution/Plutonium Oxide Recovery at LANL (Alternative 3)	Salt Scrub at Rocky Flats and Purex at SRS (Alternative 3)	Repackage at Rocky Flats (Alternative 4)	Preprocess at Rocky Flats and Acid Dissolution/Plutonium Oxide Recovery at LANL (Alternative 3)	Preprocess at Rocky Flats and Acid Dissolution/Plutonium Oxide Recovery at LANL (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
DOR Salt Residues (All Others)*	Preprocess at Rocky Flats and Acid Dissolution/Plutonium Oxide Recovery at LANL (Alternative 3)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Preprocess at Rocky Flats and Water Leach at LANL (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
Aqueous-Contaminated Combustible Residues*	Blend Down at Rocky Flats (Alternative 2)	Blend Down at Rocky Flats (Alternative 2)	Neutralize/Dry at Rocky Flats (Alternative 4)	Neutralize/Dry at Rocky Flats (Alternative 4)	MEO at Rocky Flats (Alternative 3)	Neutralize/Dry at Rocky Flats (Alternative 4)
Organic-Contaminated Combustible Residues*	Blend Down at Rocky Flats (Alternative 2)	Blend Down at Rocky Flats (Alternative 2)	Thermal Desorption/Steam Passivation at Rocky Flats (Alternative 4)	Thermal Desorption/Steam Passivation at Rocky Flats (Alternative 4)	MEO at Rocky Flats (Alternative 3)	Thermal Desorption/Steam Passivation at Rocky Flats (Alternative 4)
Dry Combustible Residues*	Blend Down at Rocky Flats (Alternative 2)	Blend Down at Rocky Flats (Alternative 2)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	MEO at Rocky Flats (Alternative 3)	Repackage at Rocky Flats (Alternative 4)

Material Category	*Minimize Total Process Duration at Rocky Flats*[a]	*Minimize Cost*	*Conduct All Processes at Rocky Flats*	*Conduct Fewest Actions at Rocky Flats*[b]	*Process with Maximum Plutonium Separation*	*Process without Plutonium Separation*
Plutonium Fluoride Residues	Preprocess at Rocky Flats and Purex at SRS (Alternative 3)	Preprocess at Rocky Flats and Purex at SRS (Alternative 3)	Acid Dissolution/ Plutonium Oxide Recovery at Rocky Flats (Alternative 3)	Preprocess at Rocky Flats and Purex at SRS (Alternative 3)	Preprocess at Rocky Flats and Purex at SRS (Alternative 3)	Blend Down at Rocky Flats (Alternative 2)
Ful Flo Filter Media Residues (IDC 331)*	Blend Down at Rocky Flats (Alternative 2)	Blend Down at Rocky Flats (Alternative 2)	Blend Down at Rocky Flats (Alternative 2)	Blend Down at Rocky Flats (Alternative 2)	MEO at Rocky Flats (Alternative 3)	Blend Down at Rocky Flats (Alternative 2)
HEPA Filter Residues (IDC 338 Only)*	Vitrify at Rocky Flats (Alternative 2)	Blend Down at Rocky Flats (Alternative 2)	Neutralize/Dry at Rocky Flats (Alternative 4)	Neutralize/Dry at Rocky Flats (Alternative 4)	MEO at Rocky Flats (Alternative 3)	Neutralize/Dry at Rocky Flats (Alternative 4)
HEPA Filter Residues (All Other HEPA Filters)*	Vitrify at Rocky Flats (Alternative 2)	Vitrify at Rocky Flats (Alternative 2)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	MEO at Rocky Flats (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
Sludge Residues (IDCs 089, 099, and 332)*	Repackage at Rocky Flats (Alternative 4)	Vitrify at Rocky Flats (Alternative 2)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4) [c]	Repackage at Rocky Flats (Alternative 4)
Sludge Residues (All Others)*	Blend Down at Rocky Flats (Alternative 2)	Blend Down at Rocky Flats (Alternative 2)	Filter/Dry at Rocky Flats (Alternative 4)	Filter/Dry at Rocky Flats (Alternative 4)	Acid Dissolution/Plutonium Oxide Recovery at Rocky Flats (Alternative 3)	Filter/Dry at Rocky Flats (Alternative 4)
Glass Residues*	Vitrify at Rocky Flats (Alternative 2)	Neutralize/Dry at Rocky Flats (Alternative 4)	Neutralize/Dry at Rocky Flats (Alternative 4)	Neutralize/Dry at Rocky Flats (Alternative 4)	MEO at Rocky Flats (Alternative 3)	Neutralize/Dry at Rocky Flats (Alternative 4)
Graphite Residues*	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Preprocess at Rocky Flats and MEO at SRS (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
Inorganic (Metal and Other) Residues*	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Repackage at Rocky Flats (Alternative 4)	Preprocess at Rocky Flats and MEO at SRS (Alternative 3)	Repackage at Rocky Flats (Alternative 4)
Scrub Alloy	Preprocess at Rocky Flats and Purex at SRS (Alternative 3)	Preprocess at Rocky Flats and Purex at SRS (Alternative 3)	Calcine and Vitrify at Rocky Flats (Alternative 2) [d]	Preprocess at Rocky Flats and Purex at SRS (Alternative 3)	Preprocess at Rocky Flats and Purex at SRS (Alternative 3)	Calcine and Vitrify at Rocky Flats (Alternative 2) [e]

STL = Safeguards termination limits SRS = Savannah River Site MEO = Mediated electrochemical oxidation HEPA = High-efficiency particulate air LANL = Los Alamos National Laboratory

[a] Minimum time to process residues and scrub alloy at Rocky Flats for shipment to the Savannah River Site, Los Alamos National Laboratory, or WIPP. All residue and scrub alloy processing in Rocky Flats Building 707 would be on the minimum process time critical path.

[b] Repackaging for some of the materials would result in fewer actions at Rocky Flats than would processing at Savannah River Site or Los Alamos National Laboratory. This is the result of necessary preprocessing operations that would have to be performed at Rocky Flats prior to transport to Savannah River Site or Los Alamos National Laboratory.

[c] No process with plutonium separation is available.

[d] Calcination/vitrification is the only proposed processing technology for scrub alloy analyzed at Rocky Flats.

[e] Calcination/vitrification is the only proposed processing technology without plutonium separation analyzed for scrub alloy.

* DOE is evaluating or may apply variances from safeguards termination limits for these material categories. Materials receiving variances could be shipped to WIPP as transuranic waste.

also store any transuranic waste generated while processing Rocky Flats plutonium residues and scrub alloy at their sites until it could be shipped to WIPP.

2.6.1 Storage of Plutonium Residues and Scrub Alloy

DOE has provided guidance on the interim safe storage of plutonium-bearing solid materials (i.e., storage for 20 years or less) in *Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials* (DOE 1995b). These criteria were promulgated to provide a DOE-wide consistent approach to ensuring safe interim storage of these plutonium-bearing materials while effecting the DOE Implementation Plan for the Defense Nuclear Facilities Safety Board's Recommendation 94-1, dated February 28, 1995. The pipe component is the baseline storage container for plutonium residues that meets requirements for disposal at WIPP. Under Alternative 1 (No Action—Stabilize and Store) and Alternative 4 (Combination of Processing Technologies), stabilized residues (except combustible residues, plutonium fluoride residues, filter media residues, and sludge residues) and scrub alloy would be stored in pipe components. Plutonium oxide, which is converted from plutonium fluoride residues under Alternative 1, would be stored as described in Section 2.6.2, below. In addition, transuranic waste produced at Rocky Flats during processing under Alternative 2 (Processing without Plutonium Separation) and Alternative 3 (Processing with Plutonium Separation) may also be stored in pipe components.

The pipe component is a flanged, stainless-steel pipe measuring 15 or 30 cm (6 or 12 inches [in]) in diameter. A lid bolted to the flange allows the residue material to be sealed within the pipe, which is placed inside a 208-L (55-gal) storage drum (**Figure 2–13**). The pipe may be fitted with a high-efficiency particulate air filter vent to release any hydrogen gas produced by radiolysis of water or organic materials. The pipe component would be used for packaging fissile gram equivalent–limited materials to achieve maximum loading of TRUPACT-II shipping containers in a manner that would prevent intermixing and criticality concerns in the event of a transportation accident. The WIPP Disposal Phase Final Supplemental EIS (DOE 1997a) includes a discussion of the pipe component and incorporates loading TRUPACT-IIs to 2,800 fissile gram equivalents. Accordingly, the WIPP waste acceptance criteria are being revised to include the pipe component and this subsequent loading limit. The pipe component would also block radiation emitted by high americium content materials at Rocky Flats, allowing them to be classified as contact-handled transuranic waste.

Before placement in a pipe component, processed plutonium residues would be packaged in containers (e.g., “bagout bags” and “produce cans”) that provide additional barriers to control inadvertent release or dispersion of the materials. Produce cans are small sealed cans in which the material would be placed while in the glovebox. Bagout bags are the plastic bags used in removing containers from a glovebox.

Residues and scrub alloy awaiting transfer to another onsite facility or an offsite facility (Savannah River Site or Los Alamos National Laboratory) for further processing would be stored temporarily in one of a number of double-containment, intrasite packages. Prior to shipment offsite, the double-contained packages would be placed into Type B containers authorized by the U.S. Department of Transportation and DOE for shipment (Section 2.8.1).

2.6.2 Storage of Plutonium Metal and Oxides

Processing the residues and scrub alloy under Alternative 3 would result in stabilized plutonium metal or oxides, which would be placed into safe and secure storage at the generating site pending disposition in accordance with decisions reached under the Storage and Disposition of Weapons-Usable Fissile Materials Final EIS (DOE 1997e) and the Surplus Plutonium Disposition EIS (DOE 1997c).

Safe, long-term storage of plutonium is addressed by DOE-STD-3013-96, *DOE Standard: Criteria for Preparing and Packaging Plutonium Metals and Oxides for Long-Term Storage* (DOE 1996f). This Standard establishes safety criteria for packaging plutonium metals and stabilized plutonium oxides to ensure safe storage for at least 50 years. The Standard applies to packaging for safe storage of plutonium metals, alloys, and oxides that contain at least 50 percent plutonium by mass. To meet the Standard, materials containing plutonium must be in stable forms and must be packaged in containers designed to maintain their integrity both under normal storage conditions and during anticipated handling accidents. The processes in Alternative 3 would produce plutonium metals and oxides that satisfy this Standard.

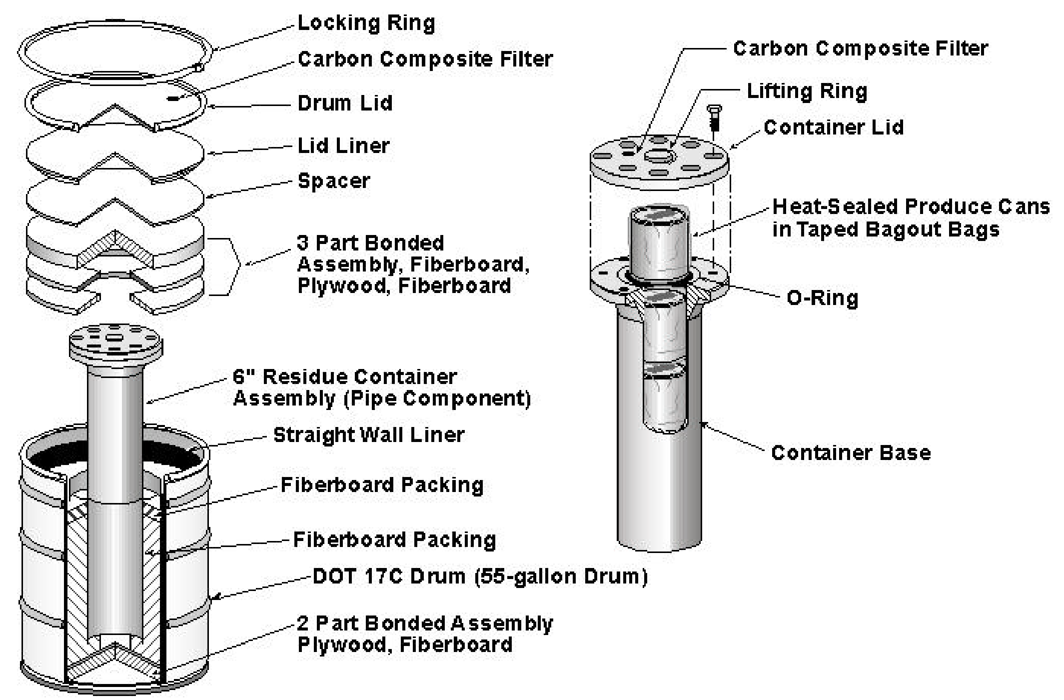

Figure 2–13 Pipe Component

2.7 DISPOSAL OR OTHER DISPOSITION

Under Alternative 1 (No Action Alternative), the plutonium residues and scrub alloy would be stabilized, repackaged and, placed in interim storage at Rocky Flats until DOE makes a final disposition decision. As there is no basis for estimating how long the stabilized residues might have to remain in storage before a disposition mechanism would be identified, DOE analyzed the annual impacts of such storage. The impacts of an arbitrary 20-year storage period are also specified in this EIS as a means of providing the public with a perspective on the effects of a prolonged storage period. A longer-term storage period was analyzed for transuranic waste for the No Action Alternative in the WIPP Disposal Phase Final Supplemental EIS (DOE 1997a). Under the Action Alternatives (i.e., Alternatives 2, 3, and 4), the residues and scrub alloy would either be processed and packaged in accordance with the WIPP waste acceptance criteria or, in the case of plutonium metal or oxide, would be packaged according to DOE-STD-3013-96 (DOE 1996f) and placed in interim storage at the processing site pending disposition in accordance with decisions made after completion of the *Surplus Plutonium Disposition EIS* (DOE 1997c). During processing, some low-level or low-level mixed waste could be produced. These waste streams would be managed according to the waste management practices for these waste types at the processing site. At the Savannah River Site, liquid waste from the Purex process would be placed in tanks with high-level waste. Solids from processing high-level waste would be vitrified and disposed of in the monitored geologic repository. Liquids would be converted into saltstone, which would be disposed of in onsite vaults.

2.7.1 Disposal of Transuranic Waste at WIPP

Transuranic waste generated from processing residues would be processed to meet the waste acceptance criteria for transuranic wastes required by WIPP (DOE 1996j). A summary of the nuclear and chemical properties of materials to meet these criteria is shown in **Table 2–5**. Some of the criteria are associated with hazardous wastes and are defined by the Resource Conservation and Recovery Act, including pyrophoric materials (reactive characteristic wastes); explosives and corrosive materials (ignitable, reactive, or corrosive characteristic wastes); and flammable volatile organic chemicals (ignitable characteristic wastes). The transuranic waste to be disposed of at WIPP would include processed residues from Alternatives 2 and 4 and most of the residual material generated in Alternative 3 after separation of plutonium metal or oxide. The environmental impacts of shipping transuranic wastes to WIPP and the impacts of disposal at that site are covered in the WIPP Disposal Phase Final Supplemental EIS (DOE 1997a). Transportation impacts are summarized and incorporated by reference in this EIS (see Appendix E, Section E.6.1).

For the purposes of this EIS, it is assumed that the TRUPACT-II shipping containers would be loaded with up to 2,800 fissile gram equivalents of plutonium-239 (up to 200 fissile gram equivalents of plutonium-239 per drum for each of 14 drums). The Nuclear Regulatory Commission (NRC 1997) certified the 2,800 fissile gram equivalents loading for the TRUPACT-II in February 1997, and the WIPP Supplemental EIS (DOE 1997a) analyzed the impacts of transporting the Rocky Flats waste utilizing this loading.

Table 2–5 Summary of Selected WIPP Waste Acceptance Criteria

Criterion	*Requirements*
Nuclear Criticality (plutonium-239 fissile gram equivalents)	Less than 200 fissile gram equivalents of plutonium-239 per drum Less than 2,800 fissile gram equivalents of plutonium-239 per TRUPACT-II[a]
Plutonium-239 Equivalent Activity	Less than or equal to 1,800 curies plutonium-239 equivalent activity for solidified/vitrified waste
Contact Dose Rate	Less than or equal to 200 millirem per hour
Thermal Power	Less than 40 watts per TRUPACT-II
Transuranic Alpha Activity	Greater than 100 nanocuries per gram of waste matrix
Pyrophoric Materials	Less than 1% radionuclide pyrophorics and no nonradionuclide pyrophorics
Explosives, Corrosives, and Compressed Gases	No compressed gases or ignitable, reactive, or corrosive wastes
Flammable Volatile Organic Chemicals	Less than or equal to 500 parts per million in container headspace

[a] This criterion was recently revised from 325 to 2,800 fissile gram equivalents of plutonium-239 per TRUPACT-II (DOE 1996j).

2.7.2 Disposition of Plutonium Oxide and Metal

Plutonium metal or oxide separated under Alternative 3 would be packaged according to DOE-STD-3013-96 (DOE 1996f) and placed in safe, secure storage at the processing site pending disposition. In the Record of Decision for the Storage and Disposition of Weapons-Usable Fissile Materials Final EIS (DOE 1997e), described in Section 1.5.6, DOE decided to pursue a two-fold strategy for plutonium disposition: (1) immobilization of some (and potentially all) of the plutonium in a glass or ceramic material for disposal in a monitored geologic repository pursuant to the Nuclear Waste Policy Act; and (2) burning of some of the plutonium as mixed-oxide (MOX) fuel in existing, domestic commercial reactors, with subsequent disposal of the spent fuel in a monitored geologic repository pursuant to the Nuclear Waste Policy Act. In July 1998, DOE published a Draft EIS on Surplus Plutonium Disposition (DOE 1997c), described in Section 1.5.7, that analyzes the impacts of implementing this plutonium strategy. Any plutonium separated under any alternative analyzed in this EIS would be disposed of using the immobilization process.

2.8 TRANSPORTATION

Transportation of plutonium residues or scrub alloy to other sites for processing would not occur under Alternative 1 (No Action—Stabilize and Store), Alternative 2 (Processing without Plutonium Separation), or Alternative 4 (Combination of Processing Technologies) because all processing would occur at Rocky Flats. Under Alternative 3 (processing with plutonium separation), however, some plutonium residues and scrub alloy would be transported to other DOE sites for processing that involves plutonium separation. Transportation of other plutonium-bearing materials (e.g., plutonium metal, plutonium oxide, and transuranic waste) that may result from the separation processes analyzed in this EIS is analyzed in other DOE EISs (Sections 1.5.4, 1.5.6, and 1.5.7).

Plutonium residues and scrub alloy have been shipped safely for 25 years. During the weapons production years (1960s to 1989), about 70 truck shipments (3,800 kg or 8,400 lb) were made from Rocky Flats to the Savannah River Site. These shipments were made using the same Transportation Safeguards System used for transporting nuclear weapons and weapon components. This same transportation system could be used in shipments of Rocky Flats plutonium residues and scrub alloy that DOE might decide to make after completion of this EIS.

The number of shipments that potentially could be sent to the Savannah River Site or Los Alamos National Laboratory under Alternative 3 for each processing technology is shown in **Table 2–6**. These shipments cannot be added to obtain the total shipments because that would lead to double counting of some shipments. Incinerator ash may be processed using either the Purex process or the mediated electrochemical oxidation process at the Savannah River Site. Accordingly, the number of shipments of this material are given for both processes. Under the Preferred Alternative, Rocky Flats would make 39 shipments to the Savannah River Site (26 for sand, slag, and crucible residues; 7 for plutonium fluoride residues; and 6 for scrub alloy) and 3 shipments to Los Alamos National Laboratory for high plutonium concentration direct oxide reduction salt residues.

Table 2–6 Possible Shipments of Plutonium Residues and Scrub Alloy for Processing with Plutonium Separation

Material Category	*Process/Site*	*Shipments*
Incinerator Ash and Firebrick Fines[a] Residues	Purex at Savannah River Site Mediated Electrochemical Oxidation at Savannah River Site	116 86
Sand, Slag, and Crucible Residues	Purex at Savannah River Site	26
Graphite Fines Residues	Mediated Electrochemical Oxidation at Savannah River Site	7
Molten Salt Extraction/ Electrorefining Salt Residues	Salt Distillation at LANL - IDC 409 Salt Distillation at LANL - All Other IDCs Purex at Savannah River Site (following scrub) - IDC 409 Purex at Savannah River Site (following scrub) - All Other IDCs	6 44 7 15
Direct Oxide Reduction Salt Residues	Acid Dissolution or Water Leach at LANL - IDCs 365, 413, 417, and 427 Acid Dissolution or Water Leach at LANL - All Other IDCs Purex at Savannah River Site (following scrub) - IDCs 365, 413, 417, and 427 Purex at Savannah River Site (following scrub) - All Other IDCs	3 10 3 1

Material Category	Process/Site	Shipments
Combustible Residues	Not shipped	
Plutonium Fluoride Residues	Purex at Savannah River Site	7
Filter Media Resources	Not shipped	
Sludge Residues	Not shipped	
Glass Residues	Not shipped	
Graphite Residues	Mediated Electrochemical Oxidation at Savannah River Site	16
Inorganic (Metal and Others) Residues	Mediated Electrochemical Oxidation at Savannah River Site	4
Existing Scrub Alloy	Purex at Savannah River Site	6

LANL = Los Alamos National Laboratory; IDC = Item Description Code
[a] Firebrick fines would not be processed by the Purex process.

DOE provides a level of safety and health for DOE transportation operations that is equivalent to or greater than that provided by compliance with applicable Federal, State, Tribal, and local regulations. In addition to meeting applicable shipping containment and confinement requirements in 10 Code of Federal Regulations (CFR) Part 71 and 49 CFR, packaging for transport of this material must be certified separately by DOE (DOE 1994b).

Four aspects of ground transportation are discussed in the following sections: (1) the ground transportation system, (2) the ground transportation route selection process, (3) emergency planning, and (4) security considerations.

2.8.1 Ground Transportation System Descriptions

Currently, DOE anticipates that any transportation of the scrub alloy and those plutonium residues with the highest plutonium concentrations would definitely be required to use the Transportation Safeguards System and would be shipped using the Safe, Secure Trailer System, which is a secure system, some details of which are classified. Nevertheless, DOE is considering whether it would be possible to use commercial carriers for shipments of plutonium residues containing low concentrations of plutonium and whether there would be any advantage to such shipments. The quantitative risk analyses (presented in detail in Appendix E) has been performed for both the commercial and Safe, Secure Trailer System. In both cases, plutonium residues and scrub alloy would be shipped from Rocky Flats to other DOE sites in Type B containers. The containers used by DOE for these shipments are authorized or certified by the Department of Transportation, DOE, and the Nuclear Regulatory Commission.

In general, scrub alloy and plutonium-bearing residues would be shipped in Type B packaging, such as the double-containment 9968 or 9975 containers, or 6M containers, after the chemical-, form-specific certificate of compliance has been obtained from DOE. On January 30, 1998, DOE issued a certificate of compliance for the 9975 container for plutonium metal and oxide. The 6M and 9975 containers are shown in **Figure 2–14**. Some of the plutonium residues could also be transported in the TRUPACT-II, a reusable certified Type B shipping package for plutonium-bearing wastes. A cutaway view of the TRUPACT-II is shown in **Figure 2–15**. The TRUPACT-II containers were specifically designed to transport transuranic waste to WIPP.

2.8.1.1 The Safe, Secure Trailer System

The Safe, Secure Trailer System is an integral part of the Transportation Safeguards System operated by the DOE Transportation Safeguards Division for the DOE Office of Defense Programs. The Transportation

Safeguards System normally is used to transport nuclear weapons, nuclear weapons components, and special nuclear materials. The Safe Secure Trailer System is a specially designed 18-wheel tractor-trailer, shown in **Figure 2–16**, which incorporates various deterrents to prevent unauthorized removal of cargo. All Safe, Secure Trailer System components undergo periodic preventive maintenance inspections and extensive maintenance checks before every trip. Additionally, DOE conducts periodic audits and surveys to ensure DOE transportation system compliance with Department of Transportation regulations.

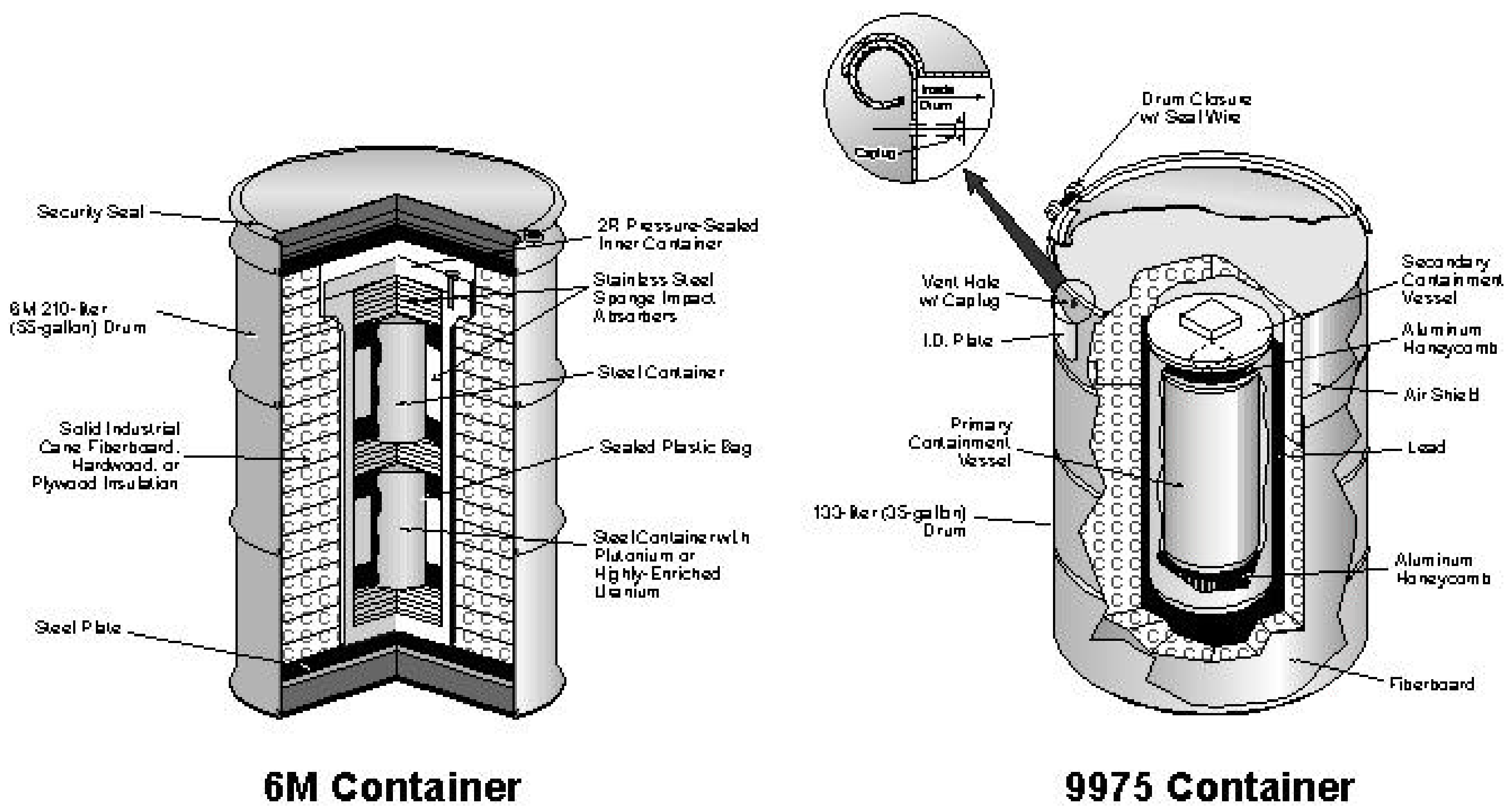

Figure 2–14 Type 6M and 9975 Transport Containers

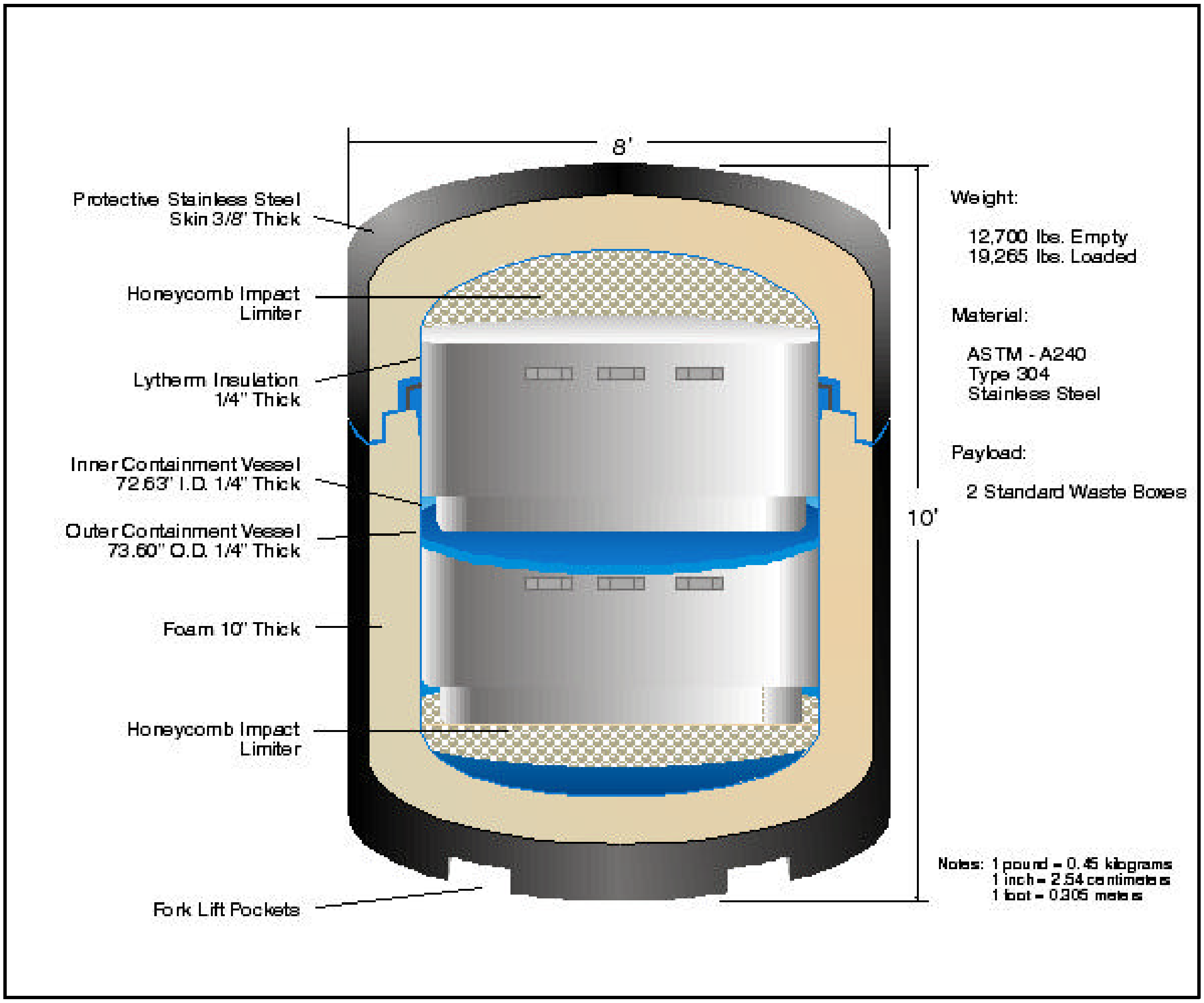

Figure 2–15 TRUPACT-II

2.8.1.2 The Commercial Transport System

The use of commercial transportation would be based on DOE's determination that the special protection and safety requirements mandated by the Nuclear Materials Safeguards Category (DOE 1994a) are not needed for a particular shipment (or shipments) because the amount of plutonium present does not require strict material control and accountability. The vehicles that would be used in this transportation system would meet maintenance and safety standards established by DOE Order 460.1A (DOE 1996d) and the Department of Transportation 49 CFR Part 396.

2.8.2 Ground Transportation Route Selection Process

DOE would develop the ground transportation routes for any residue or scrub alloy commercial shipments using a transportation planning process that would involve consultation with State and local officials.

Transportation Safeguards Division shipment routes are classified and are not publicly disclosed in order to protect national security interests. This EIS describes (in the following paragraphs) how nominal routes were chosen, based on Department of Transportation regulations incorporated in DOE Order 460.1A (DOE 1996d)

Figure 2–16 Safe, Secure Trailer System

and DOE Order 5610.12 (DOE 1994b). The actual route to be used for any shipment would be chosen based on a detailed and updated transportation planning process performed shortly before the shipment would occur. Commercial highway routing of nuclear material is systematically determined according to Department of Transportation regulations 49 CFR Parts 171-179 and 49 CFR Part 397. The Department of Transportation routing regulations require that shipment of a “highway route controlled quantity” of radioactive material be transported over a preferred highway network, including interstate highways (with preference toward interstate system bypasses and beltways around cities) and State-designated preferred routes. A State or Tribe may designate a preferred route to replace or supplement the interstate system according to Department of Transportation procedures (DOT 1992).

Carriers of highway route controlled quantities are required to use the preferred network except near the beginning or end of the trip when moving from origin to the nearest interstate or from the interstate exit nearest the destination, when making necessary repair or rest stops, or when emergency conditions render the interstate unsafe or impassible. Travel times would be a primary criterion for selecting the preferred route for a shipment and would be the primary criterion for commercial shipments.

The HIGHWAY computer code may be used for selecting highway routes in the United States. The HIGHWAY database is a computerized road atlas that currently describes approximately 386,400 kilometers (240,000 miles) of roads, including the interstate system and all U.S.-designated highways. In addition, most of the principal State highways and many local and community roads are identified. The code is updated periodically to reflect current road conditions and has been benchmarked against reported mileages and observations of commercial truck firms. Features in the HIGHWAY code allow users to select routes conforming to Department of Transportation regulations. Additionally, the HIGHWAY code contains data on population densities along the routes. The distances and populations from the HIGHWAY code are part of the information used for the transportation impact analysis (Appendix E).

Routes that may be used for the shipment of plutonium residues and scrub alloy were identified using the HIGHWAY code. These routes were selected for risk assessment purposes and do not necessarily represent the actual routes that would be used to transport nuclear materials in the future. Specific routes cannot be publicly identified in advance in part to protect national security interests. In addition, the selection of the actual route to be used would be accomplished near the time of shipment to allow the selection to consider environmental and other conditions that exist, or are predicted to exist, at the time of shipment. Such conditions might include adverse weather conditions, road conditions, bridge closures, and local traffic problems. For security reasons, details about a route would not be publicized before the shipment.

2.8.3 Emergency Management Considerations

Emergency management planning involves Federal, State, Tribal, and local governments and the general public. State, Tribal, and local agencies have responsibilities for responding to an incident involving a DOE shipment within their jurisdiction. Emergency response plans outline the organizations and their responsibilities; emergency response procedures describe how the plan would be implemented.

For ground shipments of nonweapon-related nuclear materials (including the materials addressed in this EIS), State, Tribal, and local jurisdictions along the transportation corridor review DOE's plans and procedures for response to promote their consistency with State and local actions. DOE offers a variety of emergency response resources and information to supplement the existing response system. The States and DOE have conducted evaluations to determine the current radiological response capabilities and training necessary to maintain and improve existing capabilities to allow personnel to respond effectively to a possible shipment incident.

The DOE Transportation Safeguards Division regularly conducts drills and exercises as part of their training program. DOE developed an exercise program that provides an opportunity to evaluate State and local capabilities. Exercises can enhance learning, test systems, increase awareness, and provide information to evaluate the effectiveness of training. Exercises range from table-top to full-scale exercises. Transportation exercises are held on a rotational basis among the States as needed. Transportation accident exercises are held to test DOE response capabilities and local and State systems.

DOE monitors the status and location of the shipments while maintaining 24-hour, real-time communication with every convoy. In the event of an emergency, convoy escorts would immediately contact the DOE Emergency Operations Center, which would then alert the State or local authorities designated by the States as points of contact for such emergencies. The Emergency Operations Center would also contact DOE emergency response teams, as appropriate. Law enforcement agencies in each State have been provided information on how to respond to a shipment emergency.

As part of the process of preparing this EIS, DOE met with State and local officials from affected States in Kansas City, Missouri, on April 15 and 16, 1997, and in Nashville, Tennessee, on May 7 and 8, 1997, to discuss the potential shipments of Rocky Flats plutonium residues and scrub alloy to other DOE sites for processing. Although the timing and exact routes of these shipments would be classified because of the quantities of plutonium they contain, DOE reviewed its emergency response procedures and solicited participant responses on improvements to its shipping program. DOE is fully committed to working with the State and local communities along the transportation routes to promote the safe passage of these potential shipments.

2.8.4 Security Considerations

The objective of a security system is to analyze security risks and protect against them. It is designed to detect, communicate, and respond to an incident or adversarial act directed at the shipment of nuclear material, and it may include equipped, armed (e.g., for nuclear weapons and related components), and trained escorts accompanying the shipment.

A physical security system is implemented by DOE to address health and safety considerations, to facilitate rapid response to incidents, to minimize the possibilities for theft or radiological sabotage of nuclear material, and to facilitate the location and recovery of shipments that may have come under control of unauthorized persons. Following an incident or detection of a threat directed against the shipment, measures typically are taken to communicate the incident or threat information to an emergency operations center and to initiate predetermined response actions. The measures may address neutralizing a malevolent act, recovering material, or mitigating the consequences of an incident. The security measures employed by DOE during operations with either the Commercial Transport System or the Safe, Secure Trailer System would ensure that health, safety, and environmental considerations during the transport of plutonium residues and scrub alloy would be addressed properly.

2.9 SITES, TECHNOLOGIES, AND ISSUES NOT ANALYZED

In developing the scope of this EIS, DOE considered many plutonium processing technologies, including those identified during the initial screening and evaluation process and the public scoping process, as well as four candidate processing sites. Many technologies were initially identified as having potential for processing the plutonium residues and scrub alloy because of the wide variety of chemical forms represented in the materials. This initial screening process for selecting technologies for analysis in this EIS is described briefly in the following section. As a result of the screening process and other factors discussed in the section below, DOE determined that many of the technologies that are considered technically feasible are not feasible for all or certain material types. DOE's rationale for determining whether certain technologies and DOE sites were reasonable alternatives is discussed in Section 2.9.2. Issues identified during the public scoping process that are not analyzed or are out of scope are discussed in Sections 2.9.3 and 2.9.4, respectively.

2.9.1 Initial Screening and Evaluation Process

To determine which technologies to consider in the environmental analysis of the proposed action, DOE assembled a panel of DOE and contractor technical experts and managers who were familiar with the materials within the scope of the analysis, the state of the art in processing such materials, and the current capabilities and experience of the potential processing sites.

The panel chose the technologies described in the *Rocky Flats Solid Residue Environmental Assessment* (DOE 1996k) as the basis for Alternative 1 (No Action—Stabilize and Store) for the plutonium residues. However, since the Solid Residue Environmental Assessment did not address management of scrub alloy, which is in the scope of this EIS, a suitable No Action alternative had to be selected for scrub alloy. DOE chose to analyze repackaging, if necessary, and continue storage as the No Action alternative for scrub alloy, since this would represent the minimum action that would be required to maintain the scrub alloy in its present state and would be similar in scope to the actions selected for stabilization of the plutonium residues in the Finding of No Significant Impacts for the Solid Residue Environmental Assessment.

To determine which technologies to analyze under the action alternatives, the panel assembled by DOE used a screening process that started with a review of a wide range of potential processing technologies identified in a number of earlier DOE studies (additional information on these studies is located in Section 2.3 and

| Appendix C). After identifying a preliminary set of potentially usable technologies from these studies, the DOE
| panel screened the technologies further using a set of criteria that included the following:

- Direct applicability of the technology to the particular material type
- | Maturity and timing of the technology so that processing could be accomplished in the 1998 to 2004 timeframe or earlier to meet site closure targets within reasonable cost
- Experience of the DOE site in employing the technology and availability of the facilities and equipment
- Minimization of worker exposures
- Amount of secondary wastes generated and existence of appropriate secondary waste disposition methods

Next, several working sessions were held between DOE Headquarters and site technical and management representatives to better understand the suitability of the technologies to be applied to each material type, the experience of the sites with the technologies, and the capability of the sites to implement the technologies within
| the desired time frame. Based on these discussions, DOE identified the technologies discussed in Section 2.4
| and Appendix C as reasonable technologies to include in this EIS.

The steps in the screening process described above are illustrated in **Figure 2–17.**

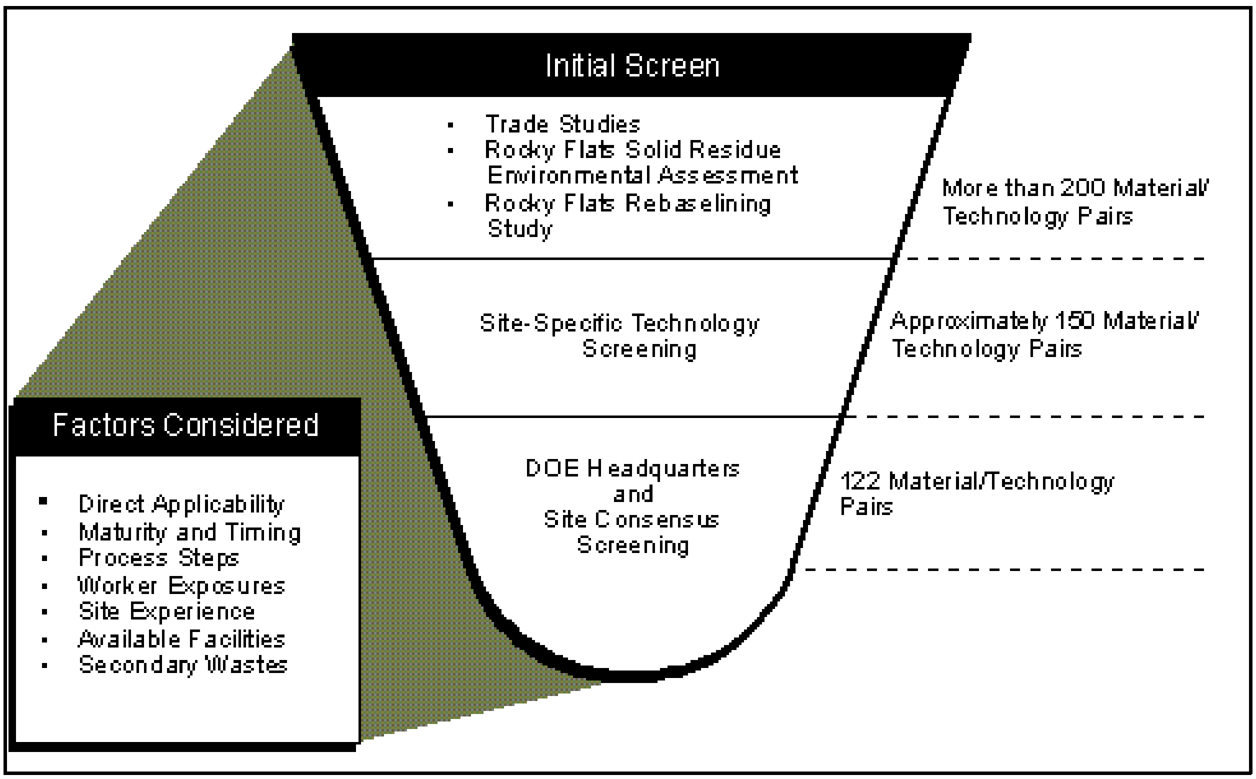

Figure 2–17 Material/Technology/Site Screening Process

2.9.2 Sites and Technologies Not Analyzed

This section discusses DOE's rationale for not further analyzing specific sites and technologies.

For Alternative 2 (Processing without Plutonium Separation), DOE is considering processing only at the Rocky Flats Site. Material transported to another site under this alternative would need to be stabilized, repackaged, or otherwise preprocessed before shipment. Because the material would be handled again at the processing site, this preprocessing would be an additional handling step that would increase costs and exposures, particularly to workers. Transportation from Rocky Flats to the processing site would increase the total materials transportation prior to disposition, thus increasing costs and total exposures to the general population and to transportation workers. DOE concluded that the preprocessing and transportation necessary to conduct processing without plutonium separation at another DOE site would increase risks and costs without providing any tangible benefits. For these reasons, DOE has determined that offsite processing without plutonium separation is unreasonable.

Lawrence Livermore and Los Alamos National Laboratories were initially considered for Alternative 3 (Processing with Plutonium Separation) because both sites have the capability to implement many of the technologies considered in this EIS. However, much of this capability is limited to laboratory bench scale operations suitable for initial development of the technology, but not for production operations. In addition, much of this limited processing capability is committed to other programs, including processing backlogs of residues from previous national laboratory operations.

Because of limitations discussed above, DOE concluded that it is unreasonable to consider the Los Alamos National Laboratory for processing most of the residue and scrub alloy at Rocky Flats. The EIS analyzes processing of pyrochemical salt residues only (for which Los Alamos National Laboratory has capabilities not found elsewhere) to preclude disrupting other ongoing Los Alamos National Laboratory activities.

The Lawrence Livermore National Laboratory has an administrative limit on the amount of plutonium that may be present there at any time that was established as a result of an agreement with the State of California. The existing plutonium inventory at Lawrence Livermore National Laboratory must be actively managed to remain under this administrative limit. This limitation would require that most or all of any residues processed at Lawrence Livermore National Laboratory be shipped an extra time, probably back to Rocky Flats, for storage. As a result of the limited capabilities and the administrative controls at the site, DOE has determined that it is unreasonable to consider Lawrence Livermore National Laboratory as a site for processing any of the Rocky Flats plutonium residues or scrub alloy.

DOE also determined that even though certain technologies for plutonium separation (Alternative 3) are feasible at some sites, the technologies are not reasonable options and are not analyzed in this EIS (see **Table 2–7**). The principal reasons for this determination were that: (1) the site has other important missions that compete for the site's limited processing capability (as discussed above), and (2) the potential processing site has limited storage capability for the plutonium residues and scrub alloy or for plutonium metal or oxides that result from processing. In particular, Los Alamos National Laboratory, Technical Area (TA)-55, as DOE's primary plutonium processing facility, has several Departmental missions that will utilize the capacity required for processing plutonium residues generated from multiple programmatic efforts. Combined with the site's limited available storage capacity, DOE determined that Los Alamos National Laboratory could only process a limited amount of plutonium residues from Rocky Flats to prevent adversely impacting the Department's other programmatic needs.

Table 2–7 Processing with Plutonium Separation: Technology/Site Combinations Not Analyzed[a]

Material Category	Specific Technology	Site(s) Dismissed
Incinerator Ash and Graphite Fines Residues	Mediated Electrochemical Oxidation	Rocky Flats
Molten Salt Extraction/Electrorefining Salts	Salt Distillation Salt Scrub	SRS SRS, LANL
Direct Oxide Reduction Salts	Water Leach Salt Scrub	SRS SRS, LANL
Plutonium Fluoride Residues	Acid Dissolution	LANL
Combustible Residues	Mediated Electrochemical Oxidation	SRS, LANL
High-Efficiency Particulate Air Filter Media Residues	Immobilization (Vitrification)	SRS
Graphite Residues	Mediated Electrochemical Oxidation	LANL
Inorganic Residues	Mediated Electrochemical Oxidation	LANL

[a] Refer to the text for the reasons that these technology/site combinations were not analyzed.
SRS = Savannah River Site
LANL = Los Alamos National Laboratory

The Savannah River Site was not considered further for separation processing of salt residues because its facilities are not designed to process material containing large quantities of chlorides. Combustible residues and wet residues such as high-efficiency particulate air filter media residues were not further considered for processing at any site other than Rocky Flats because potential radiolysis of these materials with resulting hydrogen gas generation limits the ability of DOE to transport these materials. Mediated electrochemical oxidation at Rocky Flats was not considered for removing plutonium from incinerator ash and graphite fines even though it was considered for several other plutonium residue material categories at Rocky Flats. The reason for this distinction is that Rocky Flats has the capability to process only small amounts of aqueous wastes in its liquid wastewater treatment system. The site could process the small quantity of liquid effluent that would result from mediated electrochemical oxidation processing of combustible residues, filter media residues, glass residues, graphite residues, and inorganic residues, but processing the large quantity of incinerator ash and graphite fines [approximately 15,000 kg (33,000 lb)] would produce more liquid effluent than the site could handle. Accordingly, mediated electrochemical oxidation of ash residues was dismissed as a technology at Rocky Flats.

This EIS does not consider application of a variance to safeguards termination limits for four materials: plutonium fluoride residues, high plutonium concentration direct oxide reduction salt residues, Ful Flo filter media residues, and scrub alloy. Plutonium fluoride residues have a high plutonium concentration. Repackaging this material and blending it down to the 10 percent plutonium concentration limit specified in the variance request was not considered because this procedure would expose workers to high neutron doses resulting from interactions between alpha particles emitted by plutonium and fluorine nuclei. A variance was not considered for high plutonium concentration direct oxide reduction salt residues and Ful Flo filter media residues in the Final EIS because the public was not informed in the Draft EIS that variances might be applied to these materials. DOE did not apply for a variance to the safeguards termination limit for scrub alloy because the high plutonium concentration in this material would require such extensive preprocessing (including substantial reduction of the plutonium concentration) that application of a variance is not a reasonable alternative.

2.9.3 Issues Raised During the Public Scoping Process That Are Not Analyzed

This section considers some alternatives, technologies, and other issues raised during scoping and briefly explains why they were eliminated from further analysis or otherwise were not included in this EIS.

- **Processing Residues Using the Glass Material Oxidation Dissolution System—**DOE eliminated the Glass Material Oxidation Dissolution System process from consideration because of timeliness and technical immaturity. The time required to complete the necessary research and development on technical issues (e.g., the melting process and the volume and quality of the glass products) precludes the use of the Glass Material Oxidation Dissolution System process within the 1998 to 2004 timeframe of analysis covered by this EIS.

- **Minimize Proliferation Risks through Vitrification and the "Spent Fuel Standard"—**The spent fuel standard is a concept that calls for surplus plutonium to be placed into a form that will withstand dissolution as well as spent fuel and has a radiation field, like spent fuel, that would deter access to the plutonium. This standard was put forth as a means to allow the safe disposal of fissile materials removed from nuclear weapons or fissile materials that have been purified to the point where they are suitable for use in nuclear weapons. In the plutonium residues covered by this EIS, plutonium is a minority constituent of a mixture of materials that would preclude direct use of the plutonium in a nuclear weapon. The process used to determine when such materials can be disposed of is to determine when they are in a form that is suitable for termination of safeguards. All of the plutonium separation technologies evaluated in the action alternatives in this EIS would ultimately result in conversion of the separated plutonium into either a glass or ceramic waste. The glass or ceramic waste form would then be embedded in logs of vitrified high-level radioactive waste, thus taking a form recognized as meeting the spent fuel standard.

  DOE considers processes that might convert the plutonium residues directly into a form that satisfies the spent fuel standard without first separating the plutonium from the residues not to be reasonable alternatives. First, to convert the plutonium residues directly to a form that satisfies the spent fuel standard at Rocky Flats, it would be necessary to transport high-level radioactive waste or the equivalent to Rocky Flats for use in "spiking" the waste form (i.e., adding a radiation source to the waste form to make it "self-protecting"). It also would be necessary to develop a new process and build new facilities, such as a vitrification plant, at the Rocky Flats site on an expedited basis, contrary to its current mission to clean up and shut down. Finally, it would be necessary to determine whether any waste form that might be produced would be acceptable for disposal in a geologic repository. Second, if the plutonium residues were to be converted directly into a form that meets the spent fuel standard at a site other than Rocky Flats, it would be necessary to develop and implement a new process and determine whether the final waste form that might be produced would be acceptable for disposal in a geologic repository.

  DOE concludes that there is no need to process the plutonium residues directly to the spent fuel standard to achieve nuclear weapons nonproliferation and disposition objectives for these materials, and that doing so would pose much greater difficulties than alternative means of achieving these objectives.

- **Process Scrub Alloy or Plutonium Residues Using Melt and Dilute Technology—**The melt and dilute technology is being considered by DOE as a step in the preparation of aluminum-based research reactor spent nuclear fuel for disposal, as an alternative to chemical separation. Since one of the alternatives for processing scrub alloy and plutonium residues in this EIS is chemical separation, it has been suggested that DOE should also consider application of the melt and dilute technology to the scrub alloy and plutonium residues.

  The melt and dilute technology focuses on developing techniques and equipment to mix aluminum and the aluminum-based fuel elements to form a dilute metal form that meets safeguards termination requirements and is suitable for shipment and storage. The system will have to deal with the specific characteristics of spent fuel, remote handling, and high-radiation fields. It has the advantage of being a single-step process, although that step has complications inherent in high-temperature metallurgical processing of radioactive materials.

In considering this suggestion, DOE notes the composition of aluminum-based research reactor spent nuclear fuel is considerably different from scrub alloy or plutonium residues. By comparison to the scrub alloy, the spent fuel consists of aluminum structure/cladding, enriched uranium, fission products, and a small quantity of plutonium (typically less than 1 percent). Scrub alloy is an alloy of magnesium, aluminum, americium, and plutonium, with a plutonium content of about 30 percent. Some of the scrub alloy was produced by an experimental process and contains calcium/gallium or calcium/cerium, with no aluminum. The physical form of the spent fuel is relatively long, fabricated fuel elements, whereas the form of the scrub alloy is approximately 3-inch diameter, extremely contaminated "buttons," encased in several layers of protective containment. These wide differences in physical composition, properties, and forms argues that there is no simple basis for concluding that a technology that works for aluminum-based spent fuel would also work for scrub alloy.

The differences between spent fuel and plutonium residues are even more significant. Whereas the spent fuel and scrub alloy are both metals and might be expected to dissolve in aluminum (assuming no formation of intermetallics or precipitates) to form uniform products, residues are almost never non-refractory metals. Residues consist of a number of chemical forms, including oxides, ceramics, hydrocarbons, combustibles, glasses, and salts. While pyrochemical processing is possible to make these materials compatible with the metallurgical processes employed in the melt and dilute technology, the resulting materials would contain slags, precipitates, and inclusions and would never represent uniform, diluted products. The equipment would need to handle a large number of feed configurations and would require a considerable amount of research and development. Thus, melt and dilute technology is inappropriate for processing residues.

The development of the melt and dilute technology for aluminum-based spent fuel has progressed to the point where nonirradiated mock-up fuel elements have been melted and diluted in a prototype melter in laboratory studies. In these laboratory studies, the basic metallurgy and associated physical processes have been demonstrated to be feasible and workable. Nevertheless, even with this much development completed, the technology is not expected to be fully qualified for use until approximately 2004. No similar level of development exists with respect to scrub alloy. There has been no demonstration that the process will work for scrub alloy, much less any demonstration of the specific process technologies or equipment that would be required. Consequently, it is doubtful that the melt and dilute technology could be ready for implementation by the 2006 time frame scheduled for the shut down of Rocky Flats. In consideration of these facts, DOE believes that melt and dilute technology is not appropriate to consider as a technology for processing scrub alloy or plutonium residues.

However, DOE is considering another dilution technology for scrub alloy in this EIS that does not involve plutonium separation—the calcination/vitrification process. DOE believes that this is a better process than the melt and dilute technology for scrub alloy because the technology is more mature and could be implemented with minimal changes at Rocky Flats by 2006. Furthermore, it satisfies the same objectives as the melt and dilute process, i.e., to immobilize the material without separation of plutonium in such a manner as to meet the safeguards termination limits.

- **Thermal Destruction (Incineration) of Residues at Rocky Flats—**DOE initially considered fluidized bed incineration for thermal destruction of combustible and filter media residues at Rocky Flats in the Draft EIS. Although this technology was demonstrated in previous Rocky Flats operations and at other sites, it has not been demonstrated under current Clean Air Act permitting standards. In addition, location of the facility in Building 776 has significant programmatic risk because of the condition of the facility and its schedule for decommissioning. Restart of the facility would require expenditures for updating equipment and procedures that could not be justified by the limited quantity of material that would be processed. Because of the uncertainty of the permitting process for a new or restarted facility, the estimated time to deploy this operation would be four years or more after the issuance of the Record of Decision for this EIS. Thus, DOE considers this technology to be unreasonable at Rocky Flats and has eliminated it from further consideration.

❒ **Construct a New Vitrification Facility at Rocky Flats—**DOE does not consider the construction of a large-scale vitrification facility at Rocky Flats to be economically or technically justifiable given the relatively small amounts of material requiring vitrification at the site. The "furnace vitrification" technology proposed for use at Rocky Flats produces a processed material that is encapsulated rather than incorporated in a glass matrix and would meet the specifications for terminating safeguards.

❒ **Processing at Rocky Flats Followed by Shipment Offsite for Storage—**Shipment of processed Rocky Flats plutonium residues and scrub alloy offsite for interim storage pending disposition would involve additional shipping and result in additional impacts due to extra material handling. Shipment of processed plutonium residues and scrub alloy to another site for storage would involve the additional steps of loading the materials onto trucks at Rocky Flats, shipping to another site, unloading and placing the material into storage, and potentially having to move the material again to WIPP or another DOE site for disposition. In addition, DOE's decision on storage of plutonium, as stated in the *Record of Decision for the Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1997e), is to consolidate storage of weapons-usable plutonium by upgrading and expanding existing and planned facilities at the Pantex Plant in Texas and the Savannah River Site in South Carolina. For these reasons, processing at Rocky Flats and shipment offsite for storage is not analyzed.

❒ **Construction of a New Long-Term Storage Facility at Rocky Flats—**DOE believes that long-term storage of the plutonium residues and scrub alloy at Rocky Flats is not a reasonable alternative that should be considered in this EIS for the following reasons. Long-term storage of plutonium residues and scrub alloy at Rocky Flats is not consistent with the site's cleanup and closure mission and also does not satisfy the purpose and need for agency action described in this EIS. Specifically, DOE has committed to removing all plutonium from Rocky Flats based on: the *Final Rocky Flats Cleanup Agreement* among the State of Colorado, DOE, and the U.S. Environmental Protection Agency (EPA) for Rocky Flats (CDPHE 1996); the proximity of Rocky Flats to the Denver metropolitan area; and the fact that none of the Rocky Flats facilities are in suitable condition for long-term storage. Although DOE considered development of a new plutonium storage facility (see Section 1.6), this is no longer reasonable because of DOE's decision to disposition these materials either through deep geologic disposal of the transuranic waste at WIPP or disposition of any separated plutonium in accordance with decisions under DOE's *Record of Decision on the Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* [DOE 1997e] and the *Surplus Plutonium Disposition Environmental Impact Statement* [DOE 1998]. In the event of significant delays in implementing these disposal or disposition methods, DOE would need to reevaluate its storage options.

❒ **Use of Decommissioned Minuteman Silos for Long-Term Storage of Plutonium Residues and Scrub Alloy—**DOE does not consider the use of one or more decommissioned Minuteman missile silos to store the plutonium residues or scrub alloy to be a reasonable alternative. The Strategic Arms Reduction Treaty, signed in July 1991, requires that the United States and the former Union of Soviet Socialist Republics destroy the missile silos covered by the treaty to ensure that they have been taken out of service. DOE does not want to create new DOE nuclear sites while attempting to close existing sites. Furthermore, missile silos have neither the facilities required to support the operations involved in the long-term storage of processed residues or scrub alloy, nor the capabilities for emergency response following potential accidents. The costs and regulatory requirements associated with the provision of these capabilities could be very high.

2.9.4 Issues Raised During the Public Scoping Process That Are Out of Scope

In this section, DOE briefly discusses five issues that were raised during the scoping process that it considers to be out of the scope of this EIS.

Issue 1: Reprocessing should be restarted for spent fuel from nuclear power plants. On-site basins are full, and spent fuel should not be considered waste.

DOE Response: This EIS addresses only Rocky Flats' plutonium residues and scrub alloy and, thus, does not address spent fuel.

Issue 2: DOE is overreliant on WIPP as a disposal option. Problems cited include the following:

- WIPP has not been demonstrated to be a safe disposal site and may never be proven safe.
- The opening of WIPP is uncertain (there have been delays in past; it may never open).
- Basing plans on WIPP could result in unsafe storage at Rocky Flats unless DOE plans contingencies.
- The residues and scrub alloy should be stored in a monitored, retrievable manner—which is not so with WIPP.
- Burial eliminates or strongly hinders the possible use of future cleanup technologies.
- WIPP is on Native American lands, and DOE should not push this material onto other people who have been "marginalized."
- WIPP has a pressurized brine reservoir, and there is a possibility of a breach into the environment.
- The salts at WIPP are not dry and are thus corrosive.
- Fault lines exist at WIPP which can create vertical passageways for pressurized leaking waste.
- WIPP must be shown to limit radionuclide transport for 10,000 years—plutonium has a half-life of 24,000 years, which means it remains dangerous for several hundreds of thousands of years.
- Transportation to WIPP is a problem because of the increased risks from transportation and inappropriate emergency planning along the thousands of miles along the route to WIPP.

DOE Response: This EIS addresses only the preparation of the plutonium residues and scrub alloy prior to their disposal or other disposition in accordance with the Final Supplemental WIPP EIS (DOE 1997a) and with final decisions made for disposition of the nation's surplus weapons-usable plutonium stockpile (*Record of Decision for the Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement*, [DOE 1997a] and the *Surplus Plutonium Disposition Draft Environmental Impact Statement* [DOE 1998]). If the opening of WIPP were delayed, construction of additional storage capacity at Rocky Flats may be required. This EIS does not address issues associated with disposal at WIPP or other disposition of Rocky Flats plutonium residues and scrub alloy or their transportation to WIPP.

On May 13, 1998, the EPA issued a final rulemaking that certified that the WIPP complies with the radioactive waste disposal regulations set forth at Subparts B and C of 40 CFR Part 191 (EPA 1998). The EPA also is amending the WIPP compliance criteria (40 CFR 194) by adding Appendix A that describes EPA's certification, incorporating the approval processes for waste generator sites to ship waste for disposal at WIPP. The environmental impacts of opening or not opening WIPP are analyzed in the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (DOE 1997a). This is the second supplemental EIS on WIPP. This document and its preceding documents address the impacts of operating WIPP and the impacts of transporting waste materials to WIPP, including transportation of wastes to WIPP from Rocky Flats, the Savannah River Site, and Los Alamos National Laboratory.

WIPP startup has been delayed by litigation. Radioactive waste disposal operations will begin after all legal issues have been settled. The opening of WIPP remains a high priority within DOE.

Issue 3: DOE should include in its proposed action the disposition of the enormous quantities of U-235 within the DOE complex because they pose the same level of proliferation risk as plutonium. The same controls over the materials and disposition should apply.

DOE Response: This EIS addresses only a specific amount of plutonium residues and scrub alloy at Rocky Flats that need to be processed to meet safeguards termination limits (see Chapter 1 and Appendix B of this EIS). The management and disposition of highly enriched uranium is addressed in DOE's *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (DOE 1996i) and its Record of Decision (DOE 1996h).

Issue 4: Rocky Flats needs stricter cleanup standards and should expeditiously decontaminate and decommission its facilities. The surrounding communities have already been adversely impacted by Rocky Flats's past activities. DOE should address contamination from past accidents and fires at the site.

DOE Response: This EIS analyzes the impacts of managing certain Rocky Flats plutonium residues and scrub alloy (see Chapter 4). Impacts from other site activities and cleanup standards for decommissioning and decontaminating Rocky Flats facilities are not within the scope of this EIS for decision-making purposes. Section 4.25 of Chapter 4, however, does analyze the cumulative impacts (impacts of the proposed action in this EIS along with other site activities) at the potential processing sites and the impacts of intersite transportation.

Issue 5: DOE must ensure funding will be provided for the alternatives selected (included comments for processing at the Savannah River Site and Rocky Flats). DOE must commit to a stable funding source and cover longer-term milestones; any decision should include a fully defined plan that includes a commitment for the necessary fiscal support.

DOE Response: Any commitment for funding must come from Congress. DOE will request the funding required to implement any decision that is made from this EIS and does not expect to commit to any course of action for which funding cannot reasonably be expected.

2.10 Summary of Impacts

In this section, DOE provides a summary of the products and wastes generated by each processing technology, as well as the chemical and radiological risks due to incident-free operations and transportation of each processing technology. The data for each material category or subcategory are presented in **Tables 2–8** through **2–26**. These data are discussed in detail in the appropriate sections of Chapter 4 (where the potential environmental impacts from processing each material category or subcategory are discussed), as shown in the following list:

Residue Category	*Impact Discussion*
Incinerator Ash Residues	Section 4.2
Sand, Slag, and Crucible Residues	Section 4.2
Inorganic Ash Residues	Section 4.2
Graphite Fines Residues	Section 4.2
Electrorefining and Molten Salt Extraction Residues	Section 4.3
Direct Oxide Reduction Salt residues	Section 4.3
Combustible Residues	Section 4.4
Plutonium Fluoride Residues	Section 4.5
High-Efficiency Particulate Air Filter Residues	Section 4.6
Ful Flo Filter Residues	Section 4.6
Sludge Residues	Section 4.7
Glass Residues	Section 4.8
Graphite Residues	Section 4.9
Inorganic Residues	Section 4.10
Scrub Alloy	Section 4.11

The estimates of health effects from radiation doses used in this EIS are based on the linear no-threshold theory of radiation carcinogenesis, which postulates that all radiation doses, even those close to zero, are harmful. A recent examination of low radiation studies has reported that no statistically significant low-dose radiation study was found to support the linear no-threshold theory (Polycove 1997). This finding is supported by the National Council of Radiation Protection and Measurements in a report on collective dose that states "...essentially no human data can be said to prove or even to provide direct support for the concept of collective dose with its implicit uncertainties of nonthreshold, linearity and dose-rate independence with respect to risk" (NCRP 1995). Accordingly, calculations of health impacts based on the linear no-threshold theory may overstate the actual impacts of low radiation doses and should be viewed as an upper bound on the potential health effects.

In addition to estimating the potential environmental impacts that may be obtained from processing each material category, DOE estimated the potential impacts from processing several combinations of selected technologies and sites for each residue and scrub alloy material category. These combinations, described in Section 2.5, include the No Action Alternative, DOE's Preferred Alternative, and six other combinations selected to illustrate particular management strategies. The potential environmental impacts for these alternatives are shown in **Table 2–27** and are presented in more detail in Sections 4.20 through 4.22.

DOE has also estimated key cumulative impacts at the potential processing sites and during intersite transportation for the Rocky Flats plutonium residues and scrub alloy. Cumulative radiological and hazardous chemical impacts at Rocky Flats are shown in **Tables 2–28** and **2–29**, respectively. Cumulative radiological and hazardous chemical impacts at the Savannah River Site are shown in **Tables 2–30** and **2–31**, respectively. Cumulative radiological impacts at the Los Alamos National Laboratory are shown in **Table 2–32**. The processes used at Los Alamos National Laboratory do not produce hazardous chemical emissions. The cumulative impacts for the three sites are described in more detail in Section 4.25.

Table 2–8 Impacts of Managing Incinerator Ash Residues

Impact	*Calcine/ Cement and Store at Rocky Flats (No Action Processing Technology)*	*Vitrify at Rocky Flats*	*Cold Ceramify at Rocky Flats*	*Calcine and Blend Down at Rocky Flats*	*Preprocess at Rocky Flats and Purex at Savannah River Site*	*Preprocess at Rocky Flats and MEO/Purex at Savannah River Site*	*Calcine and Cement at Rocky Flats*	*Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes								
Stabilized Residues (drums[a])	4,379	0	0	0	0	0	4,379[b]	**4,987[b]**
Transuranic Waste (drums[a])	1,310	5,428	5,379	6,430	743	846	1,310	**593**
High-Level Waste[c] (canisters[d])	0	0	0	0	4	26	0	**0**
Separated Plutonium (kg plutonium)	0	0	0	0	890	901	0	**0**
Low-Level Waste (drums[a])	2,860	1,187	1,187	1,187	1,581	1,560	2,860	**1,187**
Saltstone (cubic meters)	0	0	0	0	1,351	670	0	**0**
Radiological Risks Due to Incident-Free Operations and Transportation								
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	1.2×10^{-10}	1.7×10^{-11}	1.9×10^{-11}	9.5×10^{-11}	5.5×10^{-6}	5.5×10^{-6}	1.2×10^{-10}	$\mathbf{1.0\times10^{-11}}$
Offsite Public Population Risk (number of latent cancer fatalities)	2.6×10^{-6}	7.0×10^{-7}	7.5×10^{-7}	2.0×10^{-6}	0.0058	0.0042	2.6×10^{-6}	$\mathbf{4.0\times10^{-7}}$
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.15	0.072	0.057	0.092	0.16	0.11	0.13	**0.036**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation								
Offsite Public Maximally Exposed Individual • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 N/E 1×10^{-9}	 N/E 6×10^{-10}	 N/E N/E	 **N/E** **N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	0.0015[e]	0.0011[e]	N/E	**N/E**
Maximally Exposed Individual Involved Worker • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 N/E 2×10^{-8}	 N/E 8×10^{-9}	 N/E N/E	 **N/E** **N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	[e]	[e]	N/E	**N/E**

MEO = mediated electrochemical oxidation STL = Safeguards Termination Limits N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions
N/E = no emissions

[a] Standard 208-liter (55-gallon) drums.
[b] These stabilized residues could be disposed of in WIPP as transuranic waste.
[c] Some wastes from the Purex and MEO processes would be managed as high-level waste.
[d] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.
[e] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–9 Impacts of Managing Sand, Slag, and Crucible Residues

Impact	*Calcine/Cement and Store at Rocky Flats (No Action Processing Technology)*	*Vitrify at Rocky Flats*	*Calcine and Blend Down at Rocky Flats*	*Preprocess at Rocky Flats and Purex at Savannah River Site (Preferred Processing Technology)*	*Calcine and Cement at Rocky Flats*	*Repackage at Rocky Flats*
Products and Wastes						
Stabilized Residues (drums[a])	954	0	0	**0**	954[b]	773[b]
Transuranic Waste (drums[a])	278	1,175	1,394	**134**	278	278
High-Level Waste[c] (canisters[b])	0	0	0	**4**	0	0
Separated Plutonium (kg plutonium)	0	0	0	**128**	0	0
Low-Level Waste (drums[a])	607	242	242	**300**	607	607
Saltstone (cubic meters)	0	0	0	**357**	0	0
Radiological Risks Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	1.8×10^{-11}	2.3×10^{-12}	1.3×10^{-11}	$\mathbf{5.5\times10^{-6}}$	$1.8\text{x}10^{-11}$	$1.4\text{x}10^{-12}$
Offsite Public Population Risk (number of latent cancer fatalities)	3.6×10^{-7}	9.5×10^{-8}	2.9×10^{-7}	**0.0013**	$3.9\text{x}10^{-7}$	$5.5\text{x}10^{-8}$
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	**0.0008**	0.0008	0.0008
Involved Worker Population Risk (number of latent cancer fatalities)	0.023	0.010	0.013	**0.019**	0.020	0.0056
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 **N/A** $\mathbf{2.0\times10^{-9}}$	 N/E N/E	 N/E N/E
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	**0.00034**[e]	N/E	N/E
Maximally Exposed Individual Worker • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 **N/A** $\mathbf{2.0\times10^{-8}}$	 N/E N/E	 N/E N/E
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	[e]	N/E	N/E

N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Some wastes from the Purex process would be managed as high-level waste.

[d] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

[e] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–10 Impacts of Managing Graphite Fines Ash Residues

Impact	*Cement and Store at Rocky Flats (No Action Processing Technology)*	*Vitrify at Rocky Flats*	*Calcine and Blend Down at Rocky Flats*	*Preprocess at Rocky Flats and MEO/Purex at Savannah River Site*	*Calcine and Cement at Rocky Flats*	*Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes						
Stabilized Residues (drums[a])	280	0	0	0	280[b]	**319[b]**
Transuranic Waste (drums[a])	87	350	414	57	87	**41**
High-Level Waste[c] (canisters[d])	0	0	0	2	0	**0**
Separated Plutonium (kg plutonium)	0	0	0	73	0	**0**
Low-Level Waste (drums[a])	186	79	79	103	186	**79**
Saltstone (cubic meters)	0	0	0	43	0	**0**
Radiological Risks Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	1.0×10^{-11}	1.4×10^{-12}	$7.5x10^{-12}$	5.5×10^{-6}	1.0×10^{-11}	$\mathbf{8.0\times10^{-13}}$
Offsite Public Population Risk (number of latent cancer fatalities)	2.1×10^{-7}	5.5×10^{-8}	$1.6x10^{-7}$	0.00035	2.1×10^{-7}	$\mathbf{3.2\times10^{-8}}$
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.012	0.0060	0.0072	0.0087	0.010	**0.0029**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 N/E 2×10^{-9}	 N/E N/E	 **N/E** **N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	0.00009[e]	N/E	**N/E**
Maximally Exposed Individual Worker • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 N/E 2×10^{-8}	 N/E N/E	 **N/E** **N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	[e]	N/E	**N/E**

MEO = mediated electrochemical oxidation N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions

STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Some wastes from the Purex and MEO processes would be managed as high-level waste.

[d] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

[e] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–11 Impacts of Managing Inorganic Ash Residues

Impact	*Calcine/Cement and Store at Rocky Flats (No Action Processing Technology)*	*Vitrify at Rocky Flats*	*Calcine and Blend Down at Rocky Flats*	*Calcine and Cement at Rocky Flatse*	*Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes					
Stabilized Residues (drums[a])	637	0	0	637[b]	**725[b]**
Transuranic Waste (drums[a])	181	779	924	181	**77**
High-Level Waste (canisters[c])	0	0	0	0	**0**
Separated Plutonium (kg plutonium)	0	0	0	0	**0**
Low-Level Waste (drums[a])	395	152	152	395	**152**
Radiological Risks Due to Incident-Free Operations					
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	6.5×10^{-12}	9.0×10^{-13}	5.2×10^{-12}	6.5×10^{-12}	**5.5×10^{-13}**
Offsite Public Population Risk (number of latent cancer fatalities)	1.4×10^{-7}	3.8×10^{-8}	1.1×10^{-7}	1.4×10^{-7}	**2.2×10^{-8}**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.010	0.0039	0.0052	0.0072	**0.0020**
Hazardous Chemical Impacts Due to Incident-Free Operations					
Offsite Public Maximally Exposed Individual • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 **N/E** **N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	**N/E**
Maximally Exposed Individual Worker • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 **N/E** **N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	**N/E**

N/E = no emissions STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–12 Impacts of Managing Electrorefining and Molten Salt Extraction Salt Residues (IDC 409)

Impact	*Pyro-Oxidize and Store at Rocky Flats (No Action Processing Technology)*	*Pyro-Oxidize and Blend Down at Rocky Flats*	*Pyro-Oxidize and Salt Distill at Rocky Flats*	*Pyro-Oxidize and Water Leach at Rocky Flats*	*Preprocess at Rocky Flats and Salt Distill at Los Alamos National Laboratory*	*Salt Scrub at Rocky Flats and Purex at Savannah River Site*	*Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes							
Stabilized Residues (drums[a])	1,406	0	0	0	0	0	**1,410[b]**
Transuranic Waste (drums[a])	90	1,445	97	1,609	175	191	**90**
High-Level Waste[c] (canisters[d])	0	0	0	0	0	0.1	**0**
Separated Plutonium (kg plutonium)	0	0	235	228	234	228	**0**
Low-Level Waste (drums[a])	157	157	157	3,665	263	198	**157**
Saltstone (cubic meters)	0	0	0	0	0	51	**0**
Radiological Risks Due to Incident-Free Operations and Transportation							
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	6.0×10^{-12}	9.0×10^{-12}	1.1×10^{-11}	5.5×10^{-11}	5.5×10^{-6}	5.5×10^{-6}	**$1.0\text{x}10^{-11}$**
Offsite Public Population Risk (number of latent cancer fatalities)	2.5×10^{-7}	3.7×10^{-7}	4.4×10^{-7}	1.4×10^{-6}	0.00008	0.00037	**$4.1\text{x}10^{-7}$**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.042	0.078	0.024	0.057	0.017	0.033	**0.019**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation							
Offsite Public Maximally Exposed Individual							
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	5×10^{-10}	**N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	0.00007[e]	0.00009[e]	**N/E**
Maximally Exposed Individual Worker							
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	5×10^{-9}	**N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	[e]	[e]	**N/E**

N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Some wastes from the Purex process would be managed as high-level waste.

[d] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

[e] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–13 Impacts of Managing Electrorefining and Molten Salt Extraction Salt Residues (Except IDC 409)

Impact	*Pyro-Oxidize and Store at Rocky Flats (No Action Processing Technology)*	*Pyro-Oxidize and Blend Down at Rocky Flats*	*Pyro-Oxidize and Salt Distill at Rocky Flats*	*Pyro-Oxidize and Water Leach at Rocky Flats*	*Preprocess at Rocky Flats and Salt Distill at Los Alamos National Laboratory*	*Salt Scrub at Rocky Flats and Purex at Savannah River Site*	*Repackage at Rocky (Preferred Processing Technology)*
Products and Wastes							
Stabilized Residues (drums[a])	3,800	0	0	0	0	0	**3,800[b]**
Transuranic Waste (drums[a])	464	10,802	519	11,945	933	1,236	**464**
High-Level Waste[c] (canisters[d])	0	0	0	0	0	1	**0**
Separated Plutonium (kg plutonium)	0	0	569	552	558	553	**0**
Low-Level Waste (drums[a])	842	842	842	27,600	1,660	1,151	**842**
Saltstone (cubic meters)	0	0	0	0	0	384	**0**
Radiological Risks Due to Incident-Free Operations and Transportation							
Offsite Public MEI Risk (probability of a latent cancer fatality)	1.3×10^{-11}	2.2×10^{-11}	2.6×10^{-11}	1.4×10^{-10}	5.5×10^{-6}	5.5×10^{-6}	**1.3×10^{-11}**
Offsite Public Population Risk (number of latent cancer fatalities)	5.5×10^{-7}	9.0×10^{-7}	1.1×10^{-6}	3.2×10^{-6}	0.00060	0.00079	**5.5×10^{-7}**
MEI Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.092	0.19	0.059	0.14	0.094	0.081	**0.073**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation							
Offsite Public MEI							
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	1×10^{-9}	**N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	0.00029[e]	0.00020[e]	**N/E**
MEI Worker							
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	1×10^{-8}	**N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	[e]	[e]	**N/E**

N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions STL = Safeguards Termination Limits MEI = Maximally exposed individual

[a] Standard 208-liter (55-gallon) drums.
[b] These stabilized residues could be disposed of in WIPP as transuranic waste.
[c] Some wastes from the Purex process would be managed as high-level waste.
[d] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.
[e] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.
Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–14 Impacts of Managing Direct Oxide Reduction Salt Residues (IDCs 365, 413, 417, and 427)

Impact	*Pyro-Oxidize and Store at Rocky Flats (No Action Processing Technology)*	*Pyro-Oxidize and Blend Down at Rocky Flats*	*Pyro-Oxidize and Water Leach at Rocky Flats*	*Preprocess at Rocky Flats and Water Leach at LANL*	*Preprocess at Rocky Flats and Acid Dissolution/Plutonium Oxide Recovery at LANL (Preferred Processing Technology)*	*Salt Scrub at Rocky Flats and Purex at Savannah River Site*	*Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes							
Stabilized Residues (drums[a])	583	0	0	0	**0**	0	**826[b]**
Transuranic Waste (drums[a])	40	708	792	847	**865**	89	**40**
High-Level Waste[c] (canisters[d])	0	0	0	0	**0**	0.1	**0**
Separated Plutonium (kg plutonium)	0	0	133	138	**138**	134	**0**
Low-Level Waste (drums[a])	58	58	1,788	1,855	**1,855**	78	**58**
Saltstone (cubic meters)	0	0	0	0	**0**	25	**0**
Radiological Risks Due to Incident-Free Operations and Transportation							
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	3.6×10^{-12}	5.0×10^{-12}	5.5×10^{-11}	5.5×10^{-6}	**5.5×10^{-6}**	5.5×10^{-6}	**1.1×10^{-11}**
Offsite Public Population Risk (number of latent cancer fatalities)	1.5×10^{-7}	2.2×10^{-7}	1.2×10^{-6}	0.000041	**0.000041**	0.00016	**4.5×10^{-7}**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	**0.0008**	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.023	0.045	0.034	0.0058	**0.0074**	0.013	**0.011**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation							
Offsite Public Maximally Exposed Individual • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 **N/E** **N/E**	 N/E 3×10^{-10}	 **N/E** **N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	0.00004[e]	**0.00004[e]**	0.00004[e]	**N/E**
Maximally Exposed Individual Worker • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 **N/E** **N/E**	 N/E 3×10^{-9}	 **N/E** **N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	[e]	[e]	[e]	**N/E**

N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions LANL = Los Alamos National Laboratory

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Some wastes from the Purex process would be managed as high-level waste.

[d] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

[e] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

Note: The impacts from the preferred processing technology are presented in bold type. There are two preferred processing technologies for this material category. The rationale for having two preferred processing technologies is given in Section 2.4.2.

Table 2–15 Impacts of Managing Direct Oxide Reduction Salt Residues (Except IDCs 365, 413, 417, and 427)

Impact	*Pyro-Oxidize and Store at Rocky Flats (No Action Processing Technology)*	*Pyro-Oxidize and Blend Down at Rocky Flats*	*Pyro-Oxidize and Water Leach at Rocky Flats*	*Preprocess at Rocky Flats and Water Leach at LANL*	*Preprocess at Rocky Flats and Acid Dissolution/ Plutonium Oxide Recovery at LANL*	*Salt Scrub at Rocky Flats and Purex at Savannah River Site*	*Repackage at Rocky (Preferred Processing Technology)*
Products and Wastes							
Stabilized Residues (drums[a])	306	0	0	0	0	0	**306[b]**
Transuranic Waste (drums[a])	56	1,384	1,550	1,613	1,637	156	**56**
High-Level Waste[c] (canisters[d])	0	0	0	0	0	0.1	**0**
Separated Plutonium (kg plutonium)	0	0	49	50	50	49	**0**
Low-Level Waste (drums[a])	110	110	3,547	3,549	3,549	150	**110**
Saltstone (cubic meters)	0	0	0	0	0	50	**0**
Radiological Risks Due to Incident-Free Operations and Transportation							
Offsite Public MEI Risk (probability of a latent cancer fatality)	1.3×10^{-12}	1.9×10^{-12}	2.0×10^{-11}	$5.5 \text{x} 10^{-6}$	$5.5 \text{x} 10^{-6}$	5.5×10^{-6}	$\mathbf{1.3 \times 10^{-12}}$
Offsite Public Population Risk (number of latent cancer fatalities)	5.0×10^{-8}	8.0×10^{-8}	4.2×10^{-7}	0.00014	0.00014	0.000053	$\mathbf{5.0 \times 10^{-8}}$
MEI Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.016	0.017	0.012	0.012	0.015	0.015	**0.014**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation							
Offsite Public MEI • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 N/E 1×10^{-10}	 **N/E** **N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	0.00006[e]	0.00006[e]	0.00001[e]	**N/E**
MEI Worker • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 N/E 1×10^{-9}	 **N/E** **N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	[e]	[e]	[e]	**N/E**

N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions LANL = Los Alamos National Laboratory
STL = Safeguards termination limits MEI = Maximally exposed individual

[a] Standard 208-liter (55-gallon) drums.
[b] These stabilized residues could be disposed of in WIPP as transuranic waste.
[c] Some wastes from the Purex process would be managed as high-level waste.
[d] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.
[e] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.
Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–16 Impacts of Managing Combustible Residues

Impact	*Stabilize/Repackage and Store at Rocky Flats (No Action Processing Technology)*	*Sonic Wash at Rocky Flats*	*Catalytic Chemical Oxidation at Rocky Flats*	*Blend Down at Rocky Flats*	*MEO at Rocky Flats*	*Stabilize/Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes						
Stabilized Residues (drums[a])	916	0	0	0	0	**916[b]**
Transuranic Waste (drums[a])	92	423	1,275	220	1,219	**92**
High-Level Waste (canisters[c])	0	0	0	0	0	**0**
Separated Plutonium (kg plutonium)	0	0	0	0	21	**0**
Low-Level Waste (drums[a])	229	229	2,727	229	2,727	**229**
Radiological Risks Due to Incident-Free Operations						
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	1.8×10^{-12}	3.5×10^{-12}	2.3×10^{-12}	1.5×10^{-12}	3.7×10^{-12}	**1.8×10^{-12}**
Offsite Public Population Risk (number of latent cancer fatalities)	4.1×10^{-8}	7.5×10^{-8}	4.8×10^{-8}	3.2×10^{-8}	8.0×10^{-8}	**4.1×10^{-8}**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.013	0.0068	0.017	0.0027	0.0044	**0.0080**
Hazardous Chemical Impacts Due to Incident-Free Operations						
Offsite Public Maximally Exposed Individual • Probability of a cancer incidence • Hazard Index	 6×10^{-11} N/E	 1×10^{-11} N/E	 N/E 5×10^{-11}	 N/E N/E	 N/E N/E	 **6×10^{-11}** **N/E**
Offsite Public Population Risk (number of cancer incidences)	<1	<1	N/E	N/E	N/E	**<1**
Maximally Exposed Individual Worker • Probability of a cancer incidence • Hazard Index	 3×10^{-9} N/E	 7×10^{-10} N/E	 N/E 3×10^{-9}	 N/E N/E	 N/E N/E	 **3×10^{-9}** **N/E**
Worker Population Risk (number of cancer incidences)	<1	<1	N/E	N/E	N/E	**<1**

N/E = no emissions STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–17 Impacts of Managing Plutonium Fluoride Residues

Impact	*Acid Dissolution/Plutonium Oxide Recovery and Storage at Rocky Flats (No Action Processing Technology)*	*Blend Down at Rocky Flats*	*Acid Dissolution/Plutonium Oxide Recovery at Rocky Flats*	*Preprocess at Rocky Flats and Purex at Savannah River Site (Preferred Processing Technology)*
Products and Wastes				
Stabilized Residues (drums[a])	141	0	0	**0**
Transuranic Waste (drums[a])	333	3,923	333	**40**
High-Level Waste[b] (canisters[c])	0	0	0	**0.2**
Separated Plutonium (kg plutonium)	0	0	141	**141**
Low-Level Waste (drums[a])	750	60	750	**105**
Saltstone (cubic meters)	0	0	0	**18**
Radiological Risks Due to Incident-Free Operations and Transportation				
Offsite Public MEI Risk (probability of a latent cancer fatality)	2.2×10^{-11}	0	2.2×10^{-11}	**5.5×10^{-6}**
Offsite Public Population Risk (number of latent cancer fatalities)	4.9×10^{-7}	0	4.9×10^{-7}	**0.00036**
MEI Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	**0.008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.019	0.142	0.018	**0.029**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation				
Offsite Public MEI				
• Probability of a cancer incidence	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	**1×10^{-9}**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	**0.00009[d]**
MEI Worker				
• Probability of a cancer incidence	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	**2×10^{-8}**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	**[d]**

N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions MEI = maximally exposed individual

[a] Standard 208-liter (55-gallon) drums.

[b] Some wastes from the Purex process would be managed as high-level waste.

[c] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

[d] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–18 Impacts of Managing Ful Flo Filter Residues (IDC 331)

Impact	*Neutralize/Dry and Store at Rocky Flats (No Action Processing Technology)*	*Blend Down at Rocky Flats (Preferred Processing Technology)*	*Sonic Wash at Rocky Flats*	*MEO at Rocky Flats*
Products and Wastes				
Stabilized Residues (drums[a])	1,517	**0**	0	0
Transuranic Waste (drums[a])	65	**269**	343	860
High-Level Waste (canisters[b])	0	**0**	0	0
Separated Plutonium (kg plutonium)	0	**0**	0	19
Low-Level Waste (drums[a])	166	**166**	166	1,919
Radiological Risks Due to Incident-Free Operations				
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	2.1×10^{-12}	**1.4×10^{-12}**	2.8×10^{-12}	2.8×10^{-12}
Offsite Public Population Risk (number of latent cancer fatalities)	4.4×10^{-8}	**2.9×10^{-8}**	6.0×10^{-8}	6.0×10^{-8}
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	**0.0008**	0.0008	0.0008
Involved Worker Population Risk (number of latent cancer fatalities)	0.011	**0.0022**	0.0036	0.0025
Hazardous Chemical Impacts Due to Incident-Free Operations				
Offsite Public Maximally Exposed Individual				
• Probability of a cancer incidence	N/E	**N/E**	7×10^{-12}	N/E
• Hazard Index	N/E	**N/E**	N/E	N/E
Offsite Public Population Risk (number of cancer incidences)	N/E	**N/E**	<1	N/E
Maximally Exposed Individual Worker				
• Probability of a cancer incidence	N/E	**N/E**	4×10^{-10}	N/E
• Hazard Index	N/E	**N/E**	N/E	N/E
Worker Population Risk (number of cancer incidences)	N/E	**N/E**	<1	N/E

MEO = mediated electrochemical oxidation N/E = no emissions STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.

[b] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

Note: The impacts from preferred processing technology are presented in bold type.

Table 2–19 Impacts of Managing High-Efficiency Particulate Air Filter Residues (IDC 338)

Impact	*Neutralize/Dry and Store at Rocky Flats (No Action Processing Technology)*	*Vitrify at Rocky Flats*	*Blend Down at Rocky Flats*	*Sonic Wash at Rocky Flats*	*MEO at Rocky Flats*	*Neutralize/Dry at Rocky Flats (Preferred Processing Technology)*
Products and Wastes						
Stabilized Residues (drums[a])	3,223	0	0	0	0	**3,223[b]**
Transuranic Waste (drums[a])	138	656	572	730	1,827	**138**
High-Level Waste (canisters[c])	0	0	0	0	0	**0**
Separated Plutonium (kg plutonium)	0	0	0	0	88	**0**
Low-Level Waste (drums[a])	360	360	360	360	4,085	**360**
Radiological Risks Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	9.5×10^{-12}	2.1×10^{-12}	6.5×10^{-12}	1.3×10^{-11}	1.3×10^{-11}	$\mathbf{9.5\times10^{-12}}$
Offsite Public Population Risk (number of latent cancer fatalities)	2.0×10^{-7}	8.5×10^{-8}	1.3×10^{-7}	2.8×10^{-7}	2.7×10^{-7}	$\mathbf{2.0\times10^{-7}}$
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.033	0.0092	0.010	0.016	0.011	**0.016**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual						
• Probability of a cancer incidence	N/E	N/E	N/E	3×10^{-11}	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	**N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	<1	N/E	**N/E**
Maximally Exposed Individual Worker						
• Probability of a cancer incidence	N/E	N/E	N/E	2×10^{-9}	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	**N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	<1	N/E	**N/E**

N/E = no emissions   STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–20 Impacts of Managing High-Efficiency Particulate Air Filter Residues (Except IDC 338)

Impact	*Neutralize/Dry and Store at Rocky Flats (No Action Processing Technology)*	*Vitrify at Rocky Flats*	*Blend Down at Rocky Flats*	*Sonic Wash at Rocky Flats*	*MEO at Rocky Flats*	*Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes						
Stabilized Residues (drums[a])	96	0	0	0	0	**87[b]**
Transuranic Waste (drums[a])	10	48	42	53	133	**10**
High-Level Waste (canisters[c])	0	0	0	0	0	**0**
Separated Plutonium (kg plutonium)	0	0	0	0	2	**0**
Low-Level Waste (drums[a])	25	25	25	25	297	**25**
Radiological Risks Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	2.1×10^{-13}	4.7×10^{-14}	1.4×10^{-13}	3.0×10^{-13}	2.9×10^{-13}	$\mathbf{2.2x10^{-14}}$
Offsite Public Population Risk (number of latent cancer fatalities)	4.5×10^{-9}	1.9×10^{-9}	3.0×10^{-9}	6.5×10^{-9}	6.0×10^{-9}	$\mathbf{9.0x10^{-10}}$
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.00084	0.00020	0.00068	0.00035	0.00026	**0.00064**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual						
• Probability of a cancer incidence	N/E	N/E	N/E	7×10^{-13}	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	**N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	<1	N/E	**N/E**
Maximally Exposed Individual Worker						
• Probability of a cancer incidence	N/E	N/E	N/E	4×10^{-11}	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	**N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	<1	N/E	**N/E**

N/E = no emissions   STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–21 Impacts of Managing Sludge Residues (IDCs 089, 099, and 332)

Impact	*Filter/Dry and Store at Rocky Flats (No Action Processing Technology)*	*Vitrify at Rocky Flats*	*Blend Down at Rocky Flats*	*Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes				
Stabilized Residues (drums[a])	45	0	0	**6[b]**
Transuranic Waste (drums[a])	2	3	8	**2**
High-Level Waste (canisters[c])	0	0	0	**0**
Separated Plutonium (kg plutonium)	0	0	0	**0**
Low-Level Waste (drums[a])	1	1	1	**1**
Radiological Risks Due to Incident-Free Operations				
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	7.0×10^{-14}	2.3×10^{-14}	1.9×10^{-14}	$\mathbf{2.0x10^{-14}}$
Offsite Public Population Risk (number of latent cancer fatalities)	1.4×10^{-9}	9.5×10^{-10}	8.0×10^{-10}	$\mathbf{8.0x10^{-10}}$
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.00040	0.000092	0.000092	**0.000072**
Hazardous Chemical Impacts Due to Incident-Free Operations				
Offsite Public Maximally Exposed Individual • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 **N/E** **N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	**N/E**
Maximally Exposed Individual Worker • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 **N/E** **N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	**N/E**

N/E = no emissions
[a] Standard 208-liter (55-gallon) drums.
[b] These stabilized residues could be disposed of in WIPP as transuranic waste.
[c] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.
Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–22 Impacts of Managing Sludge Residues (Except IDCs 089, 099, and 332)

Impact	*Filter/Dry and Store at Rocky Flats (No Action Processing Technology)*	*Vitrify at Rocky Flats*	*Blend Down at Rocky Flats*	*Acid Dissolution/Plutonium Oxide Recovery at Rocky Flats*	*Filter/Dry at Rocky Flats (Preferred Processing Technology)*
Products and Wastes					
Stabilized Residues (drums[a])	1095	0	0	0	**1,095[b]**
Transuranic Waste (drums[a])	60	216	212	653	**60**
High-Level Waste (canisters[c])	0	0	0	0	**0**
Separated Plutonium (kg plutonium)	0	0	0	25	**0**
Low-Level Waste (drums[a])	127	127	127	1,468	**127**
Radiological Risks Due to Incident-Free Operations					
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	1.8×10^{-12}	6.5×10^{-13}	1.8×10^{-12}	3.7×10^{-12}	$\mathbf{1.8\times10^{-12}}$
Offsite Public Population Risk (number of latent cancer fatalities)	3.9×10^{-8}	2.5×10^{-8}	3.9×10^{-8}	8.0×10^{-8}	$\mathbf{3.9\times10^{-8}}$
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.010	0.0026	0.0026	0.015	**0.0044**
Hazardous Chemical Impacts Due to Incident-Free Operations					
Offsite Public Maximally Exposed Individual • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 **N/E** **N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	**N/E**
Maximally Exposed Individual Worker • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 **N/E** **N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	**N/E**

N/E = no emissions STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–23 Impacts of Managing Glass Residues

Impact	*Neutralize/Dry and Store at Rocky Flats (No Action Technology)*	*Vitrify at Rocky Flats*	*Blend Down at Rocky Flats*	*Sonic Wash at Rocky Flats*	*MEO at Rocky Flats*	*Neutralize/Dry at Rocky Flats (Preferred Processing Technology)*
Products and Wastes						
Stabilized Residues (drums[a])	7	0	0	0	0	**7[b]**
Transuranic Waste (drums[a])	11	41	41	48	145	**11**
High-Level Waste (canisters[c])	0	0	0	0	0	**0**
Separated Plutonium (kg plutonium)	0	0	0	0	5	**0**
Low-Level Waste (drums[a])	27	27	27	27	321	**27**
Radiological Risks Due to Incident-Free Operations						
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	0	1.0×10^{-13}	3.6×10^{-13}	0	9.0×10^{-13}	**0**
Offsite Public Population Risk (number of latent cancer fatalities)	0	4.3×10^{-9}	7.5×10^{-9}	0	1.9×10^{-8}	**0**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.00064	0.00040	0.00044	0.00076	0.00076	**0.00060**
Hazardous Chemical Impacts Due to Incident-Free Operations						
Offsite Public Maximally Exposed Individual						
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	**N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	N/E	**N/E**
Maximally Exposed Individual Worker						
• Probability of a cancer incidence	N/E	N/E	N/E	N/E	N/E	**N/E**
• Hazard Index	N/E	N/E	N/E	N/E	N/E	**N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	N/E	**N/E**

N/E = no emissions STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.

[b] These stabilized residues could be disposed of in WIPP as transuranic waste.

[c] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–24 Impacts of Managing Graphite Residues

Impact	*Repackage and Store at Rocky Flats (No Action Processing Technology)*	*Cement at Rocky Flats*	*Vitrify at Rocky Flats*	*Blend Down at Rocky Flats*	*MEO at Rocky Flats*	*Preprocess at Rocky Flats and MEO/Purex at Savannah River Site*	*Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes							
Stabilized Residues (drums[a])	575	0	0	0	0	0	**575[b]**
Transuranic Waste (drums[a])	171	756	650	650	2,055	119	**171**
High-Level Waste[c] (canisters[d])	0	0	0	0	0	8	**0**
Separated Plutonium (kg plutonium)	0	0	0	0	95	96	**0**
Low-Level Waste (drums[a])	376	376	153	153	4,495	216	**376**
Saltstone (cubic meters)	0	0	0	0	0	104	**0**
Radiological Risks Due to Incident-Free Operations and Transportation							
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	0	1.4×10^{-12}	2.0×10^{-12}	6.8×10^{-12}	1.7×10^{-11}	5.5×10^{-6}	**0**
Offsite Public Population Risk (number of latent cancer fatalities)	0	3.0×10^{-7}	8.0×10^{-8}	1.4×10^{-7}	3.6×10^{-7}	0.00081	**0**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.010	0.014	0.0076	0.0076	0.014	0.017	**0.0072**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation							
Offsite Public Maximally Exposed Individual • Probability of a cancer incidence • Hazard Index	N/E N/E	N/E N/E	N/E N/E	N/E N/E	N/E N/E	N/E 2×10^{-9}	**N/E** **N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	N/E	0.00021[e]	**N/E**
Maximally Exposed Individual Worker • Probability of a cancer incidence • Hazard Index	N/E N/E	N/E N/E	N/E N/E	N/E N/E	N/E N/E	N/E 2×10^{-8}	**N/E** **N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	N/E	[e]	**N/E**

MEO = mediated electrochemical oxidation N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions
STL = Safeguards Termination Limits

[a] Standard 208-liter (55-gallon) drums.
[b] These stabilized residues could be disposed of in WIPP as transuranic waste.
[c] Some wastes from the Purex process would be managed as high-level waste.
[d] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.
[e] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–25 Impacts of Managing Inorganic Residues

Impact	*Repackage and Store at Rocky Flats (No Action Technology)*	*Vitrify at Rocky Flats*	*Blend Down at Rocky Flats*	*MEO at Rocky Flats*	*Preprocess at Rocky Flats and MEO/Purex at Savannah River Site*	*Repackage at Rocky Flats (Preferred Processing Technology)*
Products and Wastes						
Stabilized Residues (drums[a])	106	0	0	0	0	**106[b]**
Transuranic Waste (drums[a])	37	119	120	485	24	**37**
High-Level Waste[c] (canisters[d])	0	0	0	0	1	**0**
Separated Plutonium (kg plutonium)	0	0	0	17	18	**0**
Low-Level Waste (drums[a])	94	40	40	1,075	52	**94**
Saltstone (cubic meters)	0	0	0	0	19	**0**
Radiological Risks Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	0	4.2×10^{-13}	1.2×10^{-12}	3.2×10^{-12}	5.5×10^{-6}	**0**
Offsite Public Population Risk (number of latent cancer fatalities)	0	1.7×10^{-8}	2.6×10^{-8}	6.5×10^{-8}	0.0002	**0**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	0.0008	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.0019	0.0015	0.0019	0.0030	0.0035	**0.0013**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation						
Offsite Public Maximally Exposed Individual • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 N/E 2×10^{-9}	 **N/E** **N/E**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	0.0005[e]	**N/E**
Maximally Exposed Individual Worker • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 N/E N/E	 N/E N/E	 N/E 2×10^{-8}	 **N/E** **N/E**
Worker Population Risk (number of cancer incidences)	N/E	N/E	N/E	N/E	[e]	**N/E**

MEO = mediated electrochemical oxidation N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions
STL = Safeguards termination limits

[a] Standard 208-liter (55-gallon) drums.
[b] These stabilized residues could be disposed of in WIPP as transuranic waste.
[c] Some wastes from the Purex process would be managed as high-level waste.
[d] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.
[e] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–26 Impacts of Managing Scrub Alloy

Impact	*Repackage and Store at Rocky Flats (No Action Processing Technology)*	*Calcine and Vitrify at Rocky Flats*	*Preprocess at Rocky Flats and Purex at Savannah River Site (Preferred Processing Technology)*
Products and Wastes			
Repackaged Scrub Alloy (drums[a])	276	0	**0**
Transuranic Waste (drums[a])	59	2,809	**61**
High-Level Waste[b] (canisters[c])	0	0	**0.3**
Separated Plutonium (kg plutonium)	0	0	**200**
Low-Level Waste (drums[a])	140	140	**167**
Saltstone (cubic meters)	0	0	**103**
Radiological Risks Due to Incident-Free Operations and Transportation			
Offsite Public Maximally Exposed Individual Risk (probability of a latent cancer fatality)	2.1×10^{-11}	3.2×10^{-11}	**5.5×10^{-6}**
Offsite Public Population Risk (number of latent cancer fatalities)	8.5×10^{-7}	1.2×10^{-6}	**0.00031**
Maximally Exposed Individual Involved Worker Risk (probability of a latent cancer fatality)	0.0008	0.0008	**0.0008**
Involved Worker Population Risk (number of latent cancer fatalities)	0.014	0.057	**0.024**
Hazardous Chemical Impacts Due to Incident-Free Operations and Transportation			
Offsite Public Maximally Exposed Individual • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 **N/E** **2×10^{-9}**
Offsite Public Population Risk (number of cancer incidences)	N/E	N/E	**0.00008[d]**
Maximally Exposed Individual Worker • Probability of a cancer incidence • Hazard Index	 N/E N/E	 N/E N/E	 **N/E** **2×10^{-8}**
Worker Population Risk (number of cancer incidences)	N/E	N/E	[d]

N/A = not applicable; the maximally exposed individual is undefined for vehicle emissions N/E = no emissions

[a] Standard 208-liter (55-gallon) drums.

[b] Some wastes from the Purex process would be managed as high-level waste.

[c] Each canister is 61 centimeters (2 feet) in diameter, 300 centimeters (10 feet) tall, and contains approximately 1,680 kilograms (3,700 pounds) of high-level waste glass.

[d] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

Note: The impacts from the preferred processing technology are presented in bold type.

Table 2–27 Impacts of the Alternatives and Management Approaches

Impact	Management Approaches							
	No Action Alternative	*Preferred Alternative*[a]	*Minimize Total Process Duration at Rocky Flats*	*Minimize Cost*	*Conduct all Processes at Rocky Flats*	*Conduct Fewest Actions at Rocky Flats*	*Process with Maximum Plutonium Separation*	*Process without Plutonium Separation*
Products and Wastes								
Stabilized Residues (drums[a])	20,300	18,400[b]	8,900[b]	7,800[b]	19,200[b]	17,200[b]	700[b]	19,200[b]
Transuranic Waste [c] (drums [a])	3,500	3,200	6,600	3,400	5,600	3,200	9,300	9,200
High-Level Waste (canisters[d])	0	5	2	1	0	5	42	0
Separated Plutonium (kg)[e]	0	607	1,082	1,279	141	607	2,709	0
Low-Level Waste (drums[a])	7,500	6,400	10,400	4,900	5,500	6,400	19,900	4,800
Public and Occupational Health and Safety								
Incident-Free Radiological Risk to the Public Maximally Exposed Individual (Probability of a Latent Cancer Fatality)	2.4×10^{-10}	5.5×10^{-6}	5.5×10^{-6}	5.5×10^{-6}	1.2×10^{-10}	5.5×10^{-6}	5.5×10^{-6}	9.4×10^{-11}
Incident-Free Radiological Risk to the Public Population (Latent Cancer Fatalities)	6.0×10^{-6}	0.0020	0.0016	0.00083	4.0×10^{-6}	0.0020	0.0079	3.5×10^{-6}
Incident-Free Radiological Risk to the Maximally Exposed Individual Worker (Probability of a Latent Cancer Fatality per year)	0.00080	0.00080	0.00080	0.00080	0.00080	0.00080	0.00080	0.00080
Incident-Free Radiological Risk to the Worker Population (Latent Cancer Fatalities)	0.48	0.27	0.25	0.24	0.28	0.27	0.34	0.40
Incident-Free Chemical Risk to an Individual Member of the Public (Probability of a Latent Cancer)	6×10^{-11}	6×10^{-11}	0	0	6×10^{-11}	6×10^{-11}	0	6×10^{-11}
Incident-Free Hazard Index (Individual Member of the Public)	0	5×10^{-9}	4×10^{-9}	3×10^{-9}	0	5×10^{-9}	1×10^{-8}	0
Incident-Free Chemical Risk to the Public Population (Number of Cancers)	<1	<1	<1	<1	<1	<1	<1	<1
Incident-Free Chemical Risk to an Individual Noninvolved Worker (Probability of a Latent Cancer)	3×10^{-9}	3×10^{-9}	0	0	3×10^{-9}	3×10^{-9}	0	3×10^{-9}

Impact	Management Approaches							
	No Action Alternative	***Preferred Alternative[a]***	***Minimize Total Process Duration at Rocky Flats***	***Minimize Cost***	***Conduct all Processes at Rocky Flats***	***Conduct Fewest Actions at Rocky Flats***	***Process with Maximum Plutonium Separation***	***Process without Plutonium Separation***
Incident-Free Hazard Index (Individual Worker)	0	6×10^{-8}	5×10^{-8}	4×10^{-8}	0	6×10^{-8}	1×10^{-7}	0
Incident-Free Chemical Risk to the Noninvolved Worker Population (Number of Cancers)	<1	<1	<1	<1	<1	<1	<1	<1
Accident Risk to the Public Maximally Exposed Individual (Probability of a Latent Cancer Fatality)	0.000035	0.000038	0.000032	0.000035	0.000036	0.000038	0.000046	0.000036
Accident Risk to the Public Population (Latent Cancer or Traffic Fatalities)	0.62	0.64	0.53	0.62	0.64	0.64	0.67	0.65
Accident Risk to the Onsite Noninvolved Worker (Probability of a Latent Cancer Fatality)	0.00061	0.00070	0.00062	0.00065	0.00067	0.00070	0.00085	0.00067
Other Impacts								
Intersite Round-Trip Transportation (1,000 km)[f]	0	208	166	84	0	208	823	0
Cost (million $)[g,h]	876[i,j]	524[k]	482[k]	428[k]	510[j]	668[j]	814[l]	539[k]
Processing Duration at Rocky Flats (years)[m]	7.2	5.5[n,o]	2.6[n,p]	3.2[n]	5.1	2.8[n,q]	3.4[n,p]	10.2
Air Quality Impacts	No exceedances (See Sections 4.12 and 4.25)	No exceedances (See Sections 4.12 and 4.25)	No exceedances (See Sections 4.12 and 4.25)	No exceedances (See Sections 4.12 and 4.25)	No exceedances (See Sections 4.12 and 4.25)	No exceedances (See Sections 4.12 and 4.25)	No exceedances (See Sections 4.12 and 4.25)	No exceedances (See Sections 4.12 and 4.25)
Nuclear Nonproliferation Considerations	See Note *r*	See Note *s*	See Note *s*	See Note *s*	See Note *s*	See Note *s*	See Note *s*	See Note *s*

a Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
b These stabilized residues could be disposed of in WIPP as transuranic waste.
c Includes secondary waste generated during the processing of residues and scrub alloy such as contaminated gloves and equipment.
d Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680) kg) of high-level waste glass.
e To convert to pounds, multiply by 2.205
f To convert thousands of kilometers to thousands of miles, multiply by 0.62.
g Decisional costs for labor, site overheads, itemized equipment, residue and waste processing, waste shipment and disposal, and fissile materials disposition, plus non-decisional costs for facilities upgrades, equipment, operational readiness reviews, start-up testing, and technology and development work. Excludes adjustments for technical or schedule uncertainties.
h Millions of undiscounted 1997 dollars.
i Includes $460 million for 20 years of interim storage at Rocky Flats.

[j] Includes $220 million for facilities upgrades, equipment, operational readiness reviews, start-up testing, and technology and development work that is allocable to the clean-up of plutonium residues at Rocky Flats.

[k] Includes $190 million for facilities upgrades, equipment, operational readiness reviews, start-up testing, and technology and development work that is allocable to the clean-up of plutonium residues at Rocky Flats.

[l] Includes $250 million for facilities upgrades, equipment, operational readiness reviews, start-up testing, and technology and development work that is allocable to the clean-up of plutonium residues at Rocky Flats.

[m] Sum of durations for processing technologies with the shortest individual processing time at RF. All processes at different buildings or modules at RF are conducted concurrently. The sum of the shortest processing time at the site since longer duration processing Technologys at one facility may shorten the total duration at the site. Processing duration does not reflect technical or schedule uncertainties, deferred start-up due to technology demonstration and testing, or schedule interactions among processing technologies, facilities, or sites.

[n] Includes processes at SRS F-Canyon. Processing durations at the Savannah River Site depend on schedules for materials in programs outside the scope of this EIS.

[o] Processing duration at LANL is about four months.

[p] Processing duration at LANL is about six months.

[q] Processing duration at Los Alamos National Laboratory depends on the type of new salt distillation equipment and the timing of its installation. The duration therefore depends on schedules for materials in programs outside the scope of this EIS.

[r] The plutonium residues and scrub alloy would be left in forms that cannot be disposed of due to nuclear nonproliferation concsiderations.

[s] The plutonium residues and scrub alloy would be managed and placed in forms that can be disposed of or dispositioned in a manner that supports U.S. nuclear weapons nonproliferation policy.

Table 2–28 Rocky Flats Cumulative Radiological Impacts

Impact Category	*Notes*	*Impacts of Existing Operations*	*Plutonium Residue and Scrub Alloy Impacts*			*Impacts of Other Reasonably Foreseeable Future Actions*[a]	*Cumulative Impacts*[b]		
			Min.	*Max.*	*Preferred*		*Min.*[c]	*Max.*[d]	*Preferred*
Waste Generation									
Stabilized Residues (drums)[e]		0	0	21,300	18,400	0	0	21,300	17,600
Transuranic Waste (cubic meters)	1	6,300	400	8,200	500	4,900	11,600	19,400	11,700
Low-Level Waste (cubic meters)	1	41,000	900	12,100	900	96,000	138,000	149,000	138,000
Low-Level Mixed Waste (cubic meters)	1	21,000	0	0	0	192,000	214,000	213,000	401,000
Offsite Population									
Collective dose, 10 years (person-rem)	2	1.6	0.0046	0.024	0.0057	228	230	230	230
Number of latent cancer fatalities from collective dose	3	0.00080	2.3×10^{-6}	0.000012	2.9×10^{-6}	0.11	0.11	0.11	0.11
Offsite Maximally Exposed Individual									
Annual dose, atmospheric releases (mrem)	4	0.00047	0.00012	0.00105	0.00019	0.23	0.23	0.23	0.23
Probability of a latent cancer fatality	5	2.3×10^{-10}	6.0×10^{-11}	5.3×10^{-10}	9.5×10^{-11}	1.2×10^{-7}	1.2×10^{-7}	1.2×10^{-7}	1.2×10^{-7}
Worker Population									
Collective dose, 10 years (person-rem)	6	2,630	425	2,040	582	1,723	4,778	6,393	4,935
Number of latent cancer fatalities from collective dose	7	1.1	0.17	0.82	0.23	0.69	2.0	2.6	2.0

[a] Other reasonably foreseeable future actions include special nuclear materials management; deactivation, decontamination, and decommissioning of Rocky Flats facilities; and environmental restoration activities (DOE 1997b).

[b] Impacts of existing operations, combined impacts from processing Rocky Flats plutonium residues and scrub alloy, and impacts of other reasonably foreseeable future actions. Existing operations include those associated with the preferred alternative for combined waste management as given in Table 1.6-2 of the Waste Management Programmatic Environmental Impact Statement (DOE 1997c).

[c] Cumulative impacts, including minimum combined impacts from processing Rocky Flats plutonium residues and scrub alloy.

[d] Cumulative impacts, including maximum combined impacts from processing Rocky Flats plutonium residues and scrub alloy.

[e] Standard 208-liter (55-gallon) drums. (208 Liters is equal to 0.208 cubic meters.)

Notes:

(1) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions from Tables B.5-1, B.5-2, and B.5-3 of DOE 1997c, not counting waste requiring Access Controls Only and/or No further Action.

(2) Assumes all facilities operate concurrently for the same 10-year period. The dose due to existing operations is from Table 11.15-2 of DOE 1997c. The dose due to other reasonably foreseeable future actions is from Table 5.8-5 of DOE 1997b, minus the dose due to existing operations.

(3) Assumes 0.0005 latent cancer fatalities per person-rem.

(4) Based on (DOE 1994c) for existing operations, which contains releases for the year 1992. The dose due to other reasonably foreseeable future actions is from Table 5.8-4 of DOE 1997b.

(5) Assumes 5×10^{-7} latent cancer fatalities per mrem.

(6) Assumes that all facilities operate concurrently for the same 10-year period. The dose due to existing operations is based on the 1996 dose to workers of 263 person-rem (DOE 1997b). The dose due to other reasonably foreseeable future actions is the sum of the doses in Table 5.8-1 of DOE 1997b, minus the dose for residue management.

(7) Assumes 0.0004 latent cancer fatalities per person-rem.

Table 2–29 Cumulative Air Quality Impacts at Rocky Flats

Pollutant	***Baseline Concentration ($\mu g/m^3$)***	***Modeled Concentration ($\mu g/m^3$)***	***Concentration from Other Onsite Sources[a] ($\mu g/m^3$)***	***Total Concentration ($\mu g/m^3$)***	***Averaging Time***	***Most Stringent Regulation or Guideline ($\mu g/m^3$)***
Nitrogen Dioxide	1.4	0.00014	0.0	1.4	Annual	100
Hydrochloric Acid	0.0052	4.2×10^{-7}	0.001	0.0062	Annual	N/A
Carbon Tetrachloride	0.0024	0.000031	0.002	0.0044	Annual	N/A

N/A = not applicable

[a] Other approved onsite sources which would be operating at the same time as the plutonium residues and scrub alloy processing at Rocky Flats, based on *Rocky Flats Cumulative Impacts Document* (DOE 1997b).

Table 2–30 Savannah River Site Cumulative Radiological Impacts

Impact Category	Notes	Impacts of Existing Operations	Plutonium Residue and Scrub Alloy Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Min.	Max.	Preferred		Min.[c]	Max.[d]	Preferred
Waste Generation									
High-Level Waste (canisters)[e]	1	4,600	0	43	5	(f)	4,600	4,643	4,605
Transuranic Waste (cubic meters)	2	17,100	0	100	10	65,000	82,100	82,200	82,110
Low-Level Waste (cubic meters)	3	500,000	0	200	42	2,500,000	3,000,000	3,000,000	3,000,000
Low-Level Mixed Waste (cubic meters)	4	13,000	0	0	0	11,000,000	11,000,000	11,000,000	11,000,000
Saltstone (cubic meters)	5	627,000	0	2,500	500	(f)	627,000	630,000	628,000
Offsite Population									
Collective dose, 10 years (person-rem)	6	68	0	0.38	0.062	686	754	754	754
Number of latent cancer fatalities from collective dose	7	0.034	0	0.00019	0.000031	0.34	0.37	0.37	0.37
Offsite Maximally Exposed Individual									
Annual dose, atmospheric releases (mrem)	8	0.14	0	0.0034	0.00057	9.8	9.9	9.9	9.9
Probability of a latent cancer fatality	9	7.0×10^{-8}	0	1.7×10^{-9}	2.9×10^{-10}	4.9×10^{-6}	5.0×10^{-6}	5.0×10^{-6}	5.0×10^{-6}
Worker Population									
Collective dose, 10 years (person-rem)	6	8,400	0	469	76	8,309	16,700	17,200	16,800
Number of latent cancer fatalities from collective dose	10	3.4	0	0.19	0.030	3.3	6.7	6.9	6.7

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to defense waste processing (DOE 1994d); tritium supply and recycle (DOE 1995c); spent nuclear fuel management, including spent nuclear fuel from foreign research reactors (DOE 1995d); other site-specific waste management actions, including environmental restoration activities (DOE 1995e); F-Canyon (DOE 1994d); interim management of nuclear materials (DOE 1995f); storage and disposition of weapons-usable fissile materials (DOE 1996a); stockpile stewardship and management (DOE 1996g); transfer of nonnuclear functions (DOE 1993); and disposition of highly enriched uranium (DOE 1996i).

[b] Impacts of existing operations, combined impacts from processing Rocky Flats plutonium residues and scrub alloy, and impacts of other reasonably foreseeable future actions. Existing operations include those associated with the preferred alternative for combined waste management as given in Table 11.17-2 of the Waste Management Programmatic EIS (DOE 1997c).

[c] Cumulative impacts, including minimum combined impacts from processing Rocky Flats plutonium residues and scrub alloy.

[d] Cumulative impacts, including maximum combined impacts from processing Rocky Flats plutonium residues and scrub alloy.

[e] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.

[f] The waste generation due to other reasonably foreseeable future actions (20 years) is included in the column of waste generation due to existing operations.

Notes:

(1) Data for existing operations from Table 1.6-2 of DOE 1997c.
(2) Data for existing operations from Tables 1.6-2 and B.5-3 of DOE 1997c.
(3) Data for existing operations from Tables 1.6-2 and B.5-1 of DOE 1997c.
(4) Data for existing operations from Tables 1.6-2 and B.5-2 of DOE 1997c.
(5) Data for existing operations from Table 5-5 of DOE 1994d.
(6) Assumes all facilities operate concurrently for the same 10-year period.
(7) Assumes 0.0005 latent cancer fatalities per person-rem.
(8) Based on (DOE 1994c) for existing operations, which contains releases for the year 1992. Cumulative impacts conservatively assume all facilities operate simultaneously and that the total radiological doses to the maximally exposed individual from processing residues and scrub alloy are received in 1 year.
(9) Assumes 5×10^{-7} latent cancer fatalities per mrem.
(10) Assumes 0.0004 latent cancer fatalities per person-rem.

Table 2–31 Cumulative Air Quality Impacts at the Savannah River Site

Pollutant	***Baseline Concentration ($\mu g/m^3$)***	***Modeled Concentration ($\mu g/m^3$)***	***Concentration from Other Onsite Sources[b]***	***Total Concentration ($\mu g/m^3$)***	***Averaging Time***	***Most Stringent Regulation or Guideline ($\mu g/m^3$)[a]***
Nitrogen Dioxide	8.8	0.039	3.6	12.4	Annual	100
Nitric Acid	50.96	0.65	4.76	56.37	24-hour	125
Hydrogen Fluoride	0.09 0.39 1.04 1.99	0.00036 0.0032 0.0032 0.0051	0.019 0.067 0.175 0.327	0.11 0.46 1.22 2.32	30-day 7-day 24-hour 12-hour	0.8 1.6 2.9 3.7
Phosphoric Acid	0.462	0.0016	0.0	0.464	24-hour	25

[a] Federal and State standards.

[b] Other approved onsite sources which would be operating at the same time as the plutonium residues and scrub alloy processing at Savannah River based on the *Storage and Disposition of Weapons - Usable Fissile Materials Final PEIS* (DOE 1996a).

Table 2–32 Los Alamos National Laboratory Cumulative Radiological Impacts

Impact Category	Notes	Impacts of Existing Operations	Plutonium Residue and Scrub Alloy Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Min.	Max.	Preferred		Min.[c]	Max.[d]	Preferred
Waste Generation									
Transuranic Waste (cubic meters)	1	10,800	0	600	200	4,400	15,200	15,800	15,400
Low-Level Waste (cubic meters)	2	150,000	0	1,300	400	325,000	475,000	476,000	475,000
Low-Level Mixed Waste (cubic meters)	3	2,770	0	0	0	980	3,750	3,750	3,750
Offsite Population									
Collective dose, 10 years (person-rem)	4	16	0	0.0024	0.00079	16.9	33	33	33
Number of latent cancer fatalities from collective dose	5	0.0079	0	1.2×10^{-6}	4.0×10^{-7}	0.0085	0.016	0.016	0.016
Offsite Maximally Exposed Individual									
Annual dose, atmospheric releases (mrem)	6	7.9	0	0.00080	0.00027	0.37	8.3	8.3	8.3
Probability of a latent cancer fatality	7	4.0×10^{-6}	0	4.0×10^{-10}	1.4×10^{-10}	1.9×10^{-7}	4.2×10^{-6}	4.2×10^{-6}	4.2×10^{-6}
Worker Population									
Collective dose, 10 years (person-rem)	4	4,580	0	160	8.8	763	5,340	5,340	5,350
Number of latent cancer fatalities from collective dose	8	1.8	0	0.064	0.0035	0.31	2.1	2.2	2.1

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to dual-axis radiographic hydrodynamic test facility (DOE 1995g), medical isotope production (DOE 1996l), transfer of nonnuclear functions (DOE 1993) and stockpile stewardship and management (DOE 1996g).

[b] Impacts of existing operations, combined impacts from processing Rocky Flats pyrochemical salts, and impacts of other reasonably foreseeable future actions. Existing operations include those associated with the preferred alternative for combined waste management as given in Table 11.9-2 of the Waste Management Programmatic Environmental Impact Statement (DOE 1997c).

[c] Cumulative impacts, including minimum combined impacts from processing Rocky Flats pyrochemical salts.

[d] Cumulative impacts, including maximum combined impacts from processing Rocky Flats pyrochemical salts.

Notes:

(1) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) from Table B.5-3 of DOE 1997c.

(2) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) from Table B.5-1 of DOE 1997c, not counting waste requiring Access Controls Only and/or No Further Action.

(3) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) from Table B.5-2 of DOE 1997c, not counting waste requiring Access Controls Only and/or No Further Action.

(4) Assumes all facilities operate concurrently for the same 10-year period.

(5) Assumes 0.0005 latent cancer fatalities per person-rem.

(6) Based on (DOE 1994c) for existing operations, which contains releases for the year 1992. Cumulative impacts conservatively assume all facilities operate simultaneously and that the total radiological doses to the maximally exposed individual from processing Rocky Flats pyrochemical salts are received in 1 year.

(7) Assumes 5×10^{-7} latent cancer fatalities per mrem.

(8) Assumes 0.0004 latent cancer fatalities per person-rem.

2.11 REFERENCES

CDPHE (Colorado Department of Public Health and Environment), 1996, "Final Rocky Flats Cleanup Agreement," July 19.

DNFSB (Defense Nuclear Facilities Safety Board), 1994, "Recommendation 94-1, Improved Schedule for Remediation in the Defense Nuclear Facilities Complex," *Federal Register*, Vol. 59, No. 106, pp. 28848–28850, Washington, DC, June.

DOE (U.S. Department of Energy), 1998, *Surplus Plutonium Disposition Draft Environmental Impact Statement*, DOE/EIS-0283-D, Office of Fissile Materials Disposition, Washington, DC, July.

DOE (U.S. Department of Energy), 1997a, *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement*, DOE/EIS-0026-S-2, Carlsbad Area Office, Carlsbad, NM, September.

DOE (U.S. Department of Energy), 1997b, *Rocky Flats Cumulative Impacts Document*, Golden, Colorado, June.

DOE (U.S. Department of Energy), 1997c, *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*, DOE/EIS-0200-F, Office of Environmental Management, Washington, DC, May.

DOE (U.S. Department of Energy), 1997d, "Record of Decision for the Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement," *Federal Register*, Vol. 62, No. 13, p. 3014, Washington, DC, January 14.

DOE (U.S. Department of Energy), 1997e, *Department of Energy Plutonium Sand, Slag, and Crucible Trade Study, Nuclear Material Stabilization Task Group, Working Draft—Trade Study Notes*, Vols. 1–3, Nuclear Material Stabilization Task Group, January 2.

DOE (U.S. Department of Energy), 1996a, *Storage and Disposition of Weapons-Usable Fissile Materials, Final Environmental Impact Statement*, DOE/EIS-0229, December.

DOE (U.S. Department of Energy), 1996b, *Department of Energy Plutonium Combustibles Trade Study, Nuclear Material Stabilization Task Group, Working Draft—Trade Study Notes*, Vols. 1–3, Nuclear Material Stabilization Task Group, December 24.

DOE (U.S. Department of Energy), 1996c, "Notice of Intent to Prepare an Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site," *Federal Register*, Vol. 61, No. 224, p. 58866, Office of Environment, Safety, and Health, Washington, DC, November 19.

DOE (U.S. Department of Energy), 1996d, DOE Order 460.1A, *Packaging and Transportation Safety*, Washington, DC, October 2.

DOE (U.S. Department of Energy), 1996e, *Ash Residues End-State Trade Study*, DOE/ID-10560, Vols. 1–3, Idaho Operations Office, October.

DOE (U.S. Department of Energy), 1996f, *DOE Standard Criteria for Preparing and Packaging Plutonium Metals and Oxides for Long-Term Storage*, DOE-STD-3013-96, Washington, DC, September.

DOE (U.S. Department of Energy), 1996g, *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*, DOE/EIS-0236, September.

DOE (U.S. Department of Energy), 1996h, "Record of Decision for the Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement," *Federal Register*, Volume 61, No. 151, pp. 40619-40629, Washington, DC, August 5.

DOE (U.S. Department of Energy), 1996i, *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement*," DOE/EIS-0240, Office of Fissile Materials Disposition, Washington, DC, June.

DOE (U.S. Department of Energy), 1996j, *Waste Acceptance Criteria for the Waste Isolation Pilot Plant*, DOE/WIPP-069-Rev. 5, Carlsbad, NM, April.

DOE (U.S. Department of Energy), DOE 1996k, *Environmental Assessment*, *Finding of No Significant Impact, and Response to Comments—Solid Residue Treatment, Repackaging, and Storage*, DOE/EA-1120, Rocky Flats Field Office, Golden, CO, April.

DOE (U.S. Department of Energy), 1996l, *Medical Isotopes Production Project: Molybdenum-99 and Related Isotopes Environmental Impact Statement*, DOE/EIS-0249, Office of Nuclear Energy, Washington, DC, April.

DOE (U.S. Department of Energy), 1996m, *Department of Energy Plutonium Scrub Alloy Trade Study, Nuclear Material Stabilization Task Group Data Package*, February 28.

DOE (U.S. Department of Energy), 1996n, *Plutonium Salts Trade Study, Nuclear Material Stabilization Task Group*, Vols. 1 and 2, February 21.

DOE (U.S. Department of Energy), 1995a, *Rocky Flats Environmental Technology Site: Direct Disposal Trade Study for Plutonium Bearing Residues*, Rocky Flats Field Office, Residue Waste Management Division, Golden, CO, November 21.

DOE (U.S. Department of Energy), 1995b, "Addendum to the Department of Energy Implementation Plan for DNFSB Recommendation 94-1," *Criteria for Interim Safe Storage of Plutonium-Bearing Solid Materials*, Washington, DC, October.

DOE (U.S. Department of Energy), 1995c, *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling*, DOE/EIS-0161, Office of Weapons Complex Reconfiguration, Washington, DC, October.

DOE (U.S. Department of Energy), 1995d, *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement*, DOE/EIS-0203, Office of Environmental Management, Idaho Operations Office, Idaho Falls, ID, April.

DOE (U.S. Department of Energy), 1995e, *Savannah River Site Waste Management Final Environmental Impact Statement*, DOE/EIS-0217, Savannah River Operations Office, Aiken, SC, July.

DOE (U.S. Department of Energy), 1995f, *Final Environmental Impact Statement, Interim Management of Nuclear Materials, Savannah River Site, Aiken, South Carolina*, DOE/EIS-0220D, Savannah River Operations Office, Aiken, SC, October.

DOE (U.S. Department of Energy), 1995g, *Dual Axis Radiographic Hydrodynamic Test Facility, Final Environmental Impact Statement,* DOE/EIS-0228, Albuquerque Operations Office, Los Alamos Area Office, Albuquerque, NM, August.

DOE (U.S. Department of Energy), 1994a, DOE Order 5633.3B, *Control and Accountability of Nuclear Materials,* Washington, DC, September 7.

DOE (U.S. Department of Energy), 1994b, DOE Order 5610.12, *Packaging and Offsite Transportation of Nuclear Components and Special Assemblies Associated with the Nuclear Explosives and Weapon Safety Program*, Washington, DC, July 26.

DOE (U.S. Department of Energy), 1994c, *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992*, DOE/EH-0360, Assistant Secretary for Environment, Safety, and Health, Office of Environmental Guidance, Washington, DC, February.

DOE (U.S. Department of Energy), 1994d, *Final F-Canyon Plutonium Solutions Environmental Impact Statement,* DOE/EIS-0219, Savannah River Operations Office, Aiken, SC, December.

DOE (U.S. Department of Energy), 1993, *Nonnuclear Consolidation Environmental Assessment*, DOE/EA-0792, Office of Defense Programs, Washington, DC, June.

DOT (U.S. Department of Transportation), 1992, *Guidelines for Selecting Preferred Highway Routes for Highway Route Controlled Quantity Shipments of Radioactive Materials,* DOT/RSPA/HMS/92-02, August.

EPA (U.S. Environmental Protection Agency), 1998, "Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the Disposal Regulations: Certification Decision; Final Rule," 40 CFR Part 194, *Federal Register*, Volume 63, No. 95, p. 27354, Washington, D.C. May 13.

Ferrera, K., 1996, *Residue Program Rebaselining: Phase I Recommendations for Rebaselining Salts, SS&C, and Graphite Fines,* October 28.

Gilmartin, T., 1997, *Residue Program Rebaselining: Phase II Recommendations for Rebaselining Ash, Combustibles, Fluorides, Sludges, Glass, and Firebrick and Inorganics,* January 17.

NRC (U.S. Nuclear Regulatory Commission), 1997, "Approval Record Model No. TRUPACT-II Package Certificate of Compliance No. 9218, Revision No. 8," February 20.

NCRP (National Council on Radiation Protection and Measurements), 1995, *Principles and application of Collective Doses in Radiation Protection*, NCRP Report No. 121, Bethesda, MD.

Polycove, M., 1997, *The Rise and Fall of the Linear No-Threshold Theory of Radiation Carcinogenesis,* Nuclear New, Vol. 40, No. 7, pp. 34-37, June.